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A MONOGRAPH

ON

CARBONICOLA, ANTHRACOMYA, AND NAIADITES.

BY

WHEELTON HIND, M.D., B.S.Lond., F.R.C.S., F.G.S.

LONDON:
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PART I.

CARBONICOLA (ANTHRACOSIA).

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CARBONICOLA, ANTHRACOMYA, AND NAIADITES.

§ I. INTRODUCTION.[1]

The fossils to be described in this Monograph are obtained, almost without exception, from the productive Coal-measures of the Carboniferous Series; whether they occur, as in Scotland, the North of Ireland, and the North of England, at the base of this formation, as well as in the Coal-measures proper; or, as in the other coal-fields of Ireland, the remainder of England and Wales, and the Continent, above the Millstone-grit, in the upper beds. They chiefly occur in ironstone bands or nodules in indurated marl, and in black carbonaceous shales, and often in such profusion as to constitute shell-beds which extend over large areas.

On the Continent it is found that the genera occurring in the Coal-measures pass up into beds of Permian age; but it is doubtful at present whether it can be shown that the same species survived through both periods.

It is not within the scope of this Monograph to attempt the correlation of the various strata found in the different coal-fields of Great Britain; indeed, the Author believes that it would be impossible to do so, from the fact that the nature and thickness of the coal-seams and intervening beds undergo such alterations in the same coal-field that the conditions affecting the deposit must have been very

[1] In working up the Bibliography of the bivalve Mollusca of the Coal-measures I have been reluctantly obliged to acknowledge that in two at least of the three genera to be described in this Monograph the names now in use must be abandoned for others which have the priority. M'Coy's name of *Carbonicola*, though accompanied by a partly erroneous diagnosis, is undoubtedly a few months older than King's *Anthracosia*, in which, too, the hinge characters described belong to a species, and not to the genus. And also there is no doubt that Prof. J. W. Dawson's *Naiadites* is older than Salter's *Anthracoptera*, although Dawson's genus originally contained members of all the genera to be described in this work.

local. I adopt the table published by Professor E. Hull in his paper[1] ('Quart. Journ. Geol. Soc.,' vol. xxxiii, 1877, p. 615), as being the result of many years' labour on the Carboniferous Series of Great Britain by the greatest authority on the subject, and because I think the various stages proposed by him are well marked out by their fossil contents; and therefore they form the best scheme for the comparison of the various horizons in different coal-fields.

THE BRITISH CARBONIFEROUS SERIES.[2]

Beds, in Descending Order, with Localities.

	Name of Formation.	*Localities.*
Essentially Fresh-water and Estuarine Beds.	STAGE G. *Upper Coal-measures.*—Reddish and grey sandstones, breccias, and clays, with thin coal-seams and limestones. Fossils (fresh-water or estuarine).—Fish (migratory); Crustacea, *Leperditia inflata;* Annelids, *Spirorbis carbonarius.*[3]	Manchester, Stoke-on-Trent, Newcastle-under-Lyne, southern part of Dudley Coal-field; Banks of the Dee, near Ruabon; Hamilton and Ayrshire, in Scotland.
	STAGE F. *Middle Coal-measures.*—Yellowish sandstones, clays, and shales, with thick coals. Fossils (fresh-water or estuarine).—Fish (migratory); Molluscs, *Anthracosia* (*Carbonicola*), *Anthracomya;* Crustacea, *Beyrichia*, *Estheria;* Annelids, *Spirorbis.* Marine species rare.	Central portions of all the coal-fields of England and Wales; Upper Coal-measures of Scotland.
Essentially Marine.	STAGE E. *Gannister Beds* (Phillips) or *Lower Coal-measures.*—Flagstones, shales, and thin coals, with hard siliceous floors (Gannister). Fossils (Marine).—Fish similar to those above (migratory); Molluscs, *Goniatites*, *Discites*, *Orthoceras*, *Posidonia* (sic), *Monotis*, *Aviculopecten*, *Anthracosia* (*Carbonicola*), *Lingula*, &c.	South Lancashire, North Staffordshire, North Wales, and South Wales.
	STAGE D. *Millstone-grit Series.*—Coarse grits, flagstones, and shales, with a few thin coal-seams. Fossils (Marine).—Similar to those of the Lower Coal-measures.	Uplands of Yorkshire, Lancashire, and Derbyshire, North Staffordshire, North and South Wales, &c.
	STAGE C. *Yoredale Series.*—Shales and grits, passing downwards into dark shales and earthy limestones. Fossils (Marine).—Including *Goniatites*, *Aviculopecten*, *Ctenodonta*, *Chonetes*, *Discina*, *Posidonomya*, *Productus*, &c.	Uplands and valleys of Lancashire, Yorkshire, and Derbyshire, North Staffordshire, Wales, &c.

[1] "On the Upper Limit of the essentially Marine Beds of the Carboniferous Group of the British Isles and adjoining Continental Districts; with Suggestions for a Fresh Classification of the Carboniferous Series."

[2] This table is inserted by the kind permission of Prof. Hull.

[3] The name *Spirorbis pusillus* is given in Etheridge's 'Catalogue of British Palæozoic Fossils.'

	Name of Formation.	*Localities.*
Essentially Marine (except Stage A in Scotland).	STAGE B. *Carboniferous Limestone.*—Massive limestone, passing northwards into several beds, with intervening shales and grits. Fossils.—Fish, Crustacea, Molluscs, Crinoids, Corals, &c., all marine species.	Wales, North and South; Derbyshire, Yorkshire, Cumberland; in Scotland, the Lower or Main Limestone.
	STAGE A. *Lower Limestone Shale and Calciferous Sandstone.*—Dark shales in some places; grits, conglomerates, and red sandstones and shales in the northern districts. Fossils (Marine).—*Spirifera cuspidata, Rhynchonella pleurodon*, &c.	South Wales, Northumberland, and Durham; in Scotland, "Calciferous Sandstone Series."
Fresh-water Beds.	BASIS. *Upper Old Red Sandstone.*—Yellow sandstones and conglomerates. Fossils (fresh-water).—Not well represented in England.	South Wales; Northumberland; Scotland (Dura Den); Ireland (Kiltorcan).

The marine or fresh-water origin of much of the Coal-measures has always been a disputed point. Palæontologists have hesitated to affirm the latter on account of the almost universal occurrence throughout the coal-fields of Europe, in some few beds at the base of the Coal-measures, of Unio-like shells with typically marine forms; but it is questionable whether the presence of the two forms together is not apparent only,—I say *apparent* because, in collecting fossils from coal-pits, there is always great difficulty in accurately determining, to within a few feet or inches, the exact bed where each one is obtained: very few indeed can be obtained *in situ*; the greater part are gathered from the spoil-heaps, where accurate reference to any horizon is next to impossible. A fresh-water bed a few inches thick would pass unnoticed, and its fossils be mixed with those from marine beds above or below it. Many very thin beds containing fossils peculiar to themselves are known to occur at many geological horizons; and, as I shall describe hereafter, certain narrow bands, containing a typical marine fauna, do occur in the Upper Carboniferous strata, only to be recognised as of marine origin by their fossil contents. So that I conceive it to be highly probable that thin fresh-water bands exist amongst the marine beds at the base of the Coal-measures, a series universally recognised as one deposited under changing conditions; and this view is borne out by Prof. Phillips ('Encyclop. Metrop.,' 1834, p. 590), who describes two bands of Unios in the Gannister Series of Lancashire.[1]

A mixture of marine and fresh-water forms in any bed may be brought about in several ways. It is highly probable that fresh-water forms would be washed down by currents and deposited with marine forms near the bar of the river in

[1] Vide *postea*, p. 15.

which they lived; or the periodical inundations of the sea might distribute marine forms in such a manner that they would be deposited in the same beds with fresh-water forms; or a river cutting its way through slightly older marine beds might re-deposit fossil forms with those living in its waters,—indeed, stratigraphical evidence as to condition is so liable to be misinterpreted, and so many different factors may have been introduced, causing a *mélange* of marine and fresh-water fauna, that more stress is to be laid on biological evidence, which, perhaps not itself altogether satisfactory when only a single genus is taken into account, becomes more satisfactory as other genera are brought forward as evidence of the main or predominant conditions existing during the deposition of any bed containing them. When, in addition to strong presumptive evidence, the great bulk of stratigraphical observations in the majority of cases would seem to show that the beds in which the genera Carbonicola (*Anthracosia*), Anthracomya, and Naiadites (*Anthracoptera*) occur are not of marine origin, from the all but universal absence of typical marine forms, it would appear to be safe to affirm a fresh-water or estuarine habitat for them.

With regard to the views of Scotch geologists on this point, I quote from Dr. John Young's memoir "On the Carboniferous Fossils of the West of Scotland" ('Trans. Geol. Soc. Glasgow,' vol. iii, 1871, p. 44), where he says, speaking of the so-called Coal Unios, "None of the shells or other fossils of the marine limestone series are found in the same beds with this group of molluscs; and it has occurred to me that in the one or two instances in which a single example of *Anthracosia* is said to have been found associated with marine shells it may have been drifted from its proper habitat, or washed out of some older bed of fresh-water strata." And again, in 1880 ('Trans. Geol. Soc. Glasgow,' vol. vi, p. 223), "As far as Scotland is concerned, I have never observed any commingling of true marine fossils in any of our mussel-band beds. The reptiles, fishes, molluscs, annelids, ostracods, and other organisms belong to genera and species that are seldom or never met with in marine limestone strata. This being the case, I believe the opinion formerly entertained, as to the marine origin of the strata of our Upper and Middle Coal-measures, especially of the bed characterised by *Anthracosia*, was an opinion based on faulty observation, and which will yet be proved to be untrue when the fossils occupying each horizon of strata come to be critically examined. Oscillations of the earth's crust may bring strata, which have been deposited under either lacustrine or estuarine conditions, into very close contact with those of true oceanic deposits, and this may be repeated again and again in the same series of beds. It becomes, therefore, the work of the palæontologist to say which of the organisms found in this commingling of beds properly belong to the sea, and which to lakes and rivers."

This is most valuable evidence, as beds of coal and ironstone occur in the

Carboniferous Limestone Series of Scotland when there is a frequent alternation of beds with a typically marine fauna with those containing *Carbonicola* and its congeners.

The Penneystone Limestone of Coalbrookdale, in which occur typically marine shells—*Edmondia*, *Sanguinolites*, *Schizodus*, and *Brachiopoda*, together with *Anthracosia* and *Naiadites* (the "Unios" of Professor Prestwich), would appear to be an exception to this view. There is, however, evidence to show that the Unio-like shells contained in this probably mainly marine bed had been washed down into it, on account of the occurrence of typical land plants in the bed. The marine fauna, too, is very interesting and characteristic, containing a much larger percentage of Lamellibranchiata than obtains in the Carboniferous Limestone as a rule, and probably indicating very shallow water and a littoral deposit. The marine fauna closely resembles that found in the Redesdale ironstone of Northumberland, with the exception that the latter does not, so far as I can learn, contain the Unio-like forms; in the "Chance Penneystone" of Coalbrookdale, where marine forms again appear, *Carbonicola*, &c., are conspicuously absent; and conversely, at the other horizons at which these shells are found, marine forms do not occur.

This view was held by Prof. Prestwich, who, in his memoir on the 'Geology of Coalbrookdale,'[1] says, "We find . . . . evidences of strong river action in the presence of transported vegetables . . . . and fluviatile shells, intermingled with the marine Testacea of the sea into which they were drifted." And again, in a note at p. 466, referring to the mixture of marine and fluviatile forms, and the question of their identification by the presence or absence of eroded beaks, "I have examined a considerable suite of shells apparently belonging to this genus (Unio), but, as they are all casts in ironstone, I have not been able to come to any very decided opinion; nevertheless the greater number of specimens exhibited no trace of erosion, but a few, and amongst them several from the Penneystone, decidedly did,"—an observation which I shall illustrate in shells from the North Staffordshire Coal-field.

Speaking of the probable condition under which the Coal-measures of Coalbrookdale were deposited, Sir R. I. Murchison says:[2]

"Doubtless, therefore, as hinted at in the preceding chapter, this tract of Coalbrookdale must originally have been a bay of the sea, into which streams of fresh water discharged materials derived from those lands, the contiguity of which has been previously inferred from the existence of fresh-water limestone in the adjacent coal-fields. This view is also quite in accordance with that of Mr. Prestwich, who is of opinion 'that the alternations of fresh-water shells with

[1] 'Trans. Geol. Soc. Lond.,' ser. 2, vol. v, pt. 3, 1840, p. 469.

[2] 'Silurian Syst.,' p. 105.

marine remains do not prove as many relative changes of land and sea, but that the Coal-measures were deposited in an estuary, into which flowed a considerable river, subject to occasional freshes; and he conceives that this position is supported by the fact of frequent alternations of coarse sandstones and conglomerates with beds of clay or shale containing the remains of the plants which have been brought down by the river."

A very important statement is made by the officers of the Geological Survey in the large memoir 'The Geology of the Yorkshire Coal-field,' p. 14:—"The few mollusca met with may be divided into two groups. One group contains shells, such as *Anthracosia* and *Anthracomya*, which are allied to recent fresh-water forms; the other group consists exclusively of marine genera, such as *Aviculopecten*, *Posidonomya*, and *Goniatites*. These two groups have never yet been found together, and the marine forms occur only on a few horizons and in beds of no great thickness;" though this evidence is rather discounted by the notice (at p. 85) of a section at Hoarstones Road showing black shale with *Anthracosia acuta*, *A. robusta*, var. B, *Aviculopecten papyraceus*, *Goniatites*, and scales of *Palæoniscus*.

The absence of *Carbonicola* (*Anthracosia*) and its allied forms from the Gannister-beds of Lancashire and Yorkshire, stage E of Professor Hull, and, indeed, with one or two exceptions, from the whole of stage E, is very marked; and I have reason to believe that he may have been misinformed by local collectors as to the true genera of the specimens: many shells which have been shown to me from these beds as *Carbonicola* and *Naiadites* I have found to be crushed specimens of *Schizodus*. This was the case with a shell figured by Mr. George Wild ('Trans. Manch. Geol. Soc.,' pt. 13, vol. xxi, pl. ii, fig. 7). I have been permitted to examine this specimen, and have no doubt as to its being *Schizodus Salteri*; and as the same shell occurs in the North Staffordshire Gannister-beds, I think it exceedingly probable that either this shell or perhaps a true *Modiola*, which is found in the Wetley Moor ironstones, has been mistaken for *Naiadites*. Strange to say, Prof. Hull has made no mention of *Anthracosia*, &c., occurring in the Penneystone of Coalbrookdale (stage E); while, as to the occurrence of *Anthracomya* in this stage in Glamorganshire, as quoted by him, this horizon is not given by Salter ('Iron Ores of Great Britain,' pt. 3, 1861).

It is important to note that in the thin marine bands of the Upper and Middle Coal-measures, with a characteristic marine fauna, differing much from that of the Gannister, especially in the paucity of Lamellibranchiata, Carbonicola (*Anthracosia*), &c., never occur.

In the North Staffordshire Coal-field there are at least two well-recognised marine beds. The one "the Gin Mine," or "Golden Twist," containing—

Goniatites excavatus, Phil.
„ *striatus*, Phil.
„ *multilobus*, Phil.
Cypricardia glabrata, Phil.
Aviculopecten, sp.
Euomphalus tuberculatus, Flem.
Pleurotomaria, sp.
Productus semireticulatus, Mart.
Spirifer Urei, Flem.
Axinus (*Schizodus*), sp.
Orthoceras, sp.
Solemya primæva, Phil.
Chonetes Laguessiana, De Kon.
Nucula gibbosa, Flem.
„ *lineata*, Phil.
Machrocheilus Michotianus, De Kon.
Bellerophon Dumontii, F. d'Orb.
Leda clavata, M'Coy.
Loxonema, sp.
Ctenodonta, sp.
Discites subsulcatus, Sow.

The other bed, occurring above the "Knowles seams" and immediately overlying the "Bay Coal," was discovered by Mr. John Ward, of Longton, in a sinking at the Foley colliery, and he states in his work on the Geology of the North Staffordshire Coal-fields,[1] "After a careful search I have failed to discover in the North Staffordshire Coal-field mollusca of a fresh-water type in direct association with those of a marine facies. In every instance where the two have approached each other the line of demarcation has been clear and distinct."

Even the beds over the Four-Foot coal of Wetley Moor and Biddulph, the beds containing *Lingula* and *Goniatites* are perfectly distinct from those containing *Carbonicola*, both in their horizon and lithological character—a fact I have been able to observe very recently in a sinking near the top of Eaves Lane, Wetley Moor.

The following fossils occur in the Bay Coal band :

Aviculopecten papyraceus, Sow.
Ctenodonta, sp.
Discina nitida, Phil.
Lingula squamiformis, Phil.
„ *mytiloides*, Sow.
Machrocheilus, sp.
Nautilus (*Discites*) *falcatus*, Sow.
Productus, sp.
Spirifer, sp.

Another such marine band in the banks of the Tame at Ashton-under-Lyme was discovered by Prof. A. H. Green, and a list of the contents is given by Mr. Salter in the Memoir on the Country round Oldham,[2] which I quote here.

Calamites, narrow ridges.
Wood.
Serpulites.
Aviculopecten fibrillosus.
„ *papyraceus*, Goldf.
Ctenodonta, sp.
Nautilus præcox.
Discites rotifer.
„ sp. 2.
„ sp. 3.
Goniatites, sp.
Orthoceras, sp., thin.
Megalichthys Hibberti, Agass.

[1] 'Trans. North Staffs Institute of Min. and Mech. Engineers,' vol. x, pt. 5, 1890, p. 49.
[2] 'Geol. Surv. Mem.,' "Geology of the Country round Oldham," 1864, p. 64.

The same writer is responsible for the following statement in his Appendix to the 'Geol. Survey Memoir, Country round Wigan,' 2nd edition, 1862, p. 43 :— "With *Goniatites*, *Anthracosia* occurs in abundance, not actually discovered in the same layers, but closely intermixed, so that it is difficult to believe that one is a fresh- and the other a salt-water shell." No other observer has made a similar statement; but he goes on to say, "*Anthracosia acuta* occurs in strata undoubtedly marine at Clitheroe;" and names the discoverer—a statement which is very vague as regards locality and horizon; and, as the specimen itself is not in evidence, it is impossible to place much reliance on this solitary find, which was probably another bivalve from the Carboniferous or Yoredale beds.

There are at least two beds in Scotland in which *Carbonicola* (*Anthracosia*) and undoubted marine fossils appear to occur together; one of these is the "Slaty-band" or "Lingula-ironstone" of Lanarkshire, which contains—

Lingula mytiloides.	*Anthracosia* (*Carbonicola*) *aquilina.*
„ *squamiformis.*	„ „ *acuta.*
Anthracosia (*Carbonicola*) *subconstricta.*	

('Mem. Geol. Survey Scotland,' Explanation of Sheet 23, pp. 89, 90, 1873.)

This bed is probably equivalent to the Gannister Series in England, and belongs to stage E.

The other bed is that at the base of the "Cement-stone Group" at Water of Leith, from which Dr. Rhind[1] and Captain T. Brown[2] have obtained a shell, according to the former, "from a bed of shale below ten feet of sandstone, but the marine character of the bed is not made out, and it is very probable from the plant remains in the Cement-stone Group that these beds are not marine. R. Etheridge, jun.,[3] records a similar shell (the original having been lost, the reference is somewhat doubtful) from hardened shale in a quarry on the north side of the Colinton Road, under Craiglockart Hill, near Edinburgh, at about the same horizon.

It has generally been considered that *Anthracoptera crassa* (the *Myalina crassa* of Fleming, Etheridge, and others), which I have shown to be anatomically identical with the Naiadites (*Anthracoptera*) of the Coal-measures,[4] is a marine shell. It occurs at Cults, Pitlessie, Fife, in a bed almost completely composed of these shells, at the west end of the workings, now almost covered with talus; but there are several broken specimens lying about with corals (*Zaphrentis*), *Aviculopecten*, fish remains (*Megalichthys*) and *Stigmaria*—a curious fauna, indicating the

[1] Rhind, 'Age of the Earth,' p. 167, pl. ii, figs. *a*, *b*.

[2] 'Ann. and Mag. Nat. Hist.,' ser. 1, vol. xii, pl. xvi, fig. 1, p. 394; 'Fossil Conchology,' p. 178, pl. lxxiii, fig. 8.

[3] 'Quart. Journ. Geol. Soc. Lond.,' vol. xxxiv, pl. ii, fig. 20, p. 16, 1878.

[4] Hind, 'Geol. Mag.,' Decade III, vol. x, Nov., 1893, p. 514.

proximity of land. The shells of *Naiadites* (*Anthracoptera*) are very large and fine; and whatever conditions obtained, they were very favorable to the growth and life of the species. As to Beith, the other locality where this shell occurs, Mr. Robert Craig writes me that it is a rare shell there except in two places, where it existed in large colonies, at Roughwood in a shale averaging three feet in thickness, which rests on a bed of coal and is very fossiliferous. The lowest two inches contain a mixture of marine and brackish water forms, above which the fossils are marine. In the Beith quarries *Myalina* is found in a shale ten inches thick, which rests on a coal, and is associated with fish remains, of brackish water origin. The real nature of these beds is therefore quite open to question. In the brackish or possibly fresh-water beds of the Cement-stone Group occurs a slighter form, which Mr. Robert Etheridge, jun., describes[1] as of slighter make than those from Cults; and he refers it to the form described by Captain Thomas Brown as *Avicula modioliformis;*[2] but he says "I cannot distinguish any characters, either external or internal, by which specifically to distinguish Captain Brown's shell from Dr. Fleming's, and I propose to adopt the name given by the former as a varietal designation for the thinner and lighter form of *Myalina crassa*."

It is quite possible that the change in size was merely due to change in environment, and that we have here an example of a species, originally marine in habitat, growing luxuriantly under marine littoral conditions, but dwindling rapidly in size, and passing off into varietal forms, under the fresh-water conditions of the Middle and Upper Coal-measures.

The universal absence of marine forms of life in the Middle and Upper Coal stages F and G throughout the coal-fields of Europe is very striking, and Continental geologists are almost unanimous in considering *Carbonicola*, *Anthracomya*, and *Naiadites* to have had a fresh-water habitat. Doubt has been thrown on this point by Salter,[3] who says, "Meantime there is yet more doubt if they can be fresh-water forms, associated as they always are with *Modiola* and other true sea animals,"—a statement certainly not borne out by observation. The association with true marine animals is certainly not "always," and the word "rarely" might have been substituted for it with greater approach to truth. But I shall show later on that Salter was led to misinterpret and neglect several previously observed and obvious anatomical facts in order to establish *Anthracosia* and his new genus *Anthracomya* as marine forms. Prof. Hull[4] states, "These bivalves (the *Anthracosia* of King) are the bane of palæontologists, and after a long consideration of their relationship to other fossils in Carboniferous strata,

[1] 'Quart. Journ. Geol. Soc. Lond.,' vol. xxxiv, p. 13, 1878.

[2] 'Foss. Conch.,' 1849, p. 162, pl. lxvi, fig. 19.

[3] 'Geol. Survey Mem.,' "Iron Ores, South Wales," pt. iii, p. 227, 1861.

[4] Supra cit., 'Quart. Journ. Geol. Soc.,' vol. xxxiii, p. 643.

and their very varying forms, I have come to the conclusion that either they were capable of inhabiting both lakes and estuaries on the one hand, and the open sea on the other, or else the marine and fresh water forms are so similar in appearance that they can only be identified by reference to those which may occur along with them in the bed. Thus when, (as in Coalbrookdale and Lancashire), [I doubt the latter locality[1]] we find them associated with undoubted marine forms, we can only conclude that they themselves were inhabitants of the sea; but if they happen to occur unaccompanied by such well-recognised forms, then we may assume that they represent lacustrine or estuarine conditions, the probability being that had the strata been formed under the sea marine shells would have been preserved along with those of this genus." I have shown above that the mixture of marine forms with *Carbonicola* (*Anthracosia*) is by no means so common as might be supposed from this remark, and that it may be accounted for in other ways than those advanced by the Professor; and I am sure that the true reason of this group of shells being a "bane to palæontologists" is because they have never been systematically collected and studied. It is perfectly astonishing to see the paucity of specimens of these shells in museums, and more so in the museums of large towns situated in coal-measure districts. It is, indeed, a matter of very considerable difficulty to obtain these fossils *in situ*, and unless the greatest care is observed, and the collector possesses an intimate acquaintance with the naked-eye characters of the various shells and rocks on the waste-heaps, it is very easy to infer that fossils which lie close together on the mound, belonging to widely separated beds, are from the same horizon. Another obstacle arises from the carelessness of many collectors in not labelling each specimen immediately it has been brought home, and often putting them by with others, so that shells from various beds become mixed and the horizons forgotten. I can testify myself to the frequent difficulty and almost impossibility of arriving at any but the approximate horizon of many specimens; often I have found some of my best specimens lying weathered-out on the rubbish-heap of a pit-bank years after the pit has ceased working, and which, from the hardness of the matrix and

[1] On the authority of Prof. Phillips (article on "Geology," 'Encyclopædia Metropolitana,' 1834, p. 590), who, in speaking of the marine shells in the Lower Coal-measures of Lancashire and Yorkshire, says, "In the midst of this series of Gannister Coal two layers of these shells [Unio] occur, one of them about the middle of the series, considerably above the Pecten Coal, and the other near the bottom, considerably below that coal." This extract is quoted by Binney in two papers on "The Marine Shells of the Lower Coal-measures" ('Manchester Geol. Soc. Trans.,' vol. i, p. 82, 1841; vol. ii, p. 75, 1860). Mr. Bolton, assistant keeper of Owens College Museum, writes me:— "In the Rossendale area of the lower coal-measures a very persistent bed of ironstone shale with ironstone, the whole charged with Carbonicola in the state of casts, occurs immediately over the Bassey or Salts Mine. The same bed has been found at Helpit Edge, Saddleworth. I am sure that careful search would prove its existence in the Haslingden district."

small size of the specimen, it would have been practically impossible to procure when the portion of the bed containing them was brought to the bank. It is also, unfortunately, only too true that miners are very fond of deceiving collectors, and handing them specimens which have been obtained from quite different localities; and had I not known the rocks and localities well, I might often have been deceived by marine fossil forms (often Carboniferous) said to have been obtained from certain horizons, which, happily I knew, could not have been the case.

A strong point in favour of the fresh-water origin of much of the coal-measures is brought forward by Prof. A. H. Green ('Coal and its Uses,' edited by Thorpe, 1878, p. 31). When discussing the want of unanimity among observers on this subject, and the distinction of the fauna of the Carboniferous Limestone from that of the Coal-measures, he says, "They [the fauna] are rarely, if ever, found together. One, we know, was marine; is it not, then, to say the least, likely that the other was fresh-water?" And in support of this view he says, "No marine amphibian is known, and we may therefore conclude that these [Labyrinthodonta] were fluviatile in their habit."

In the same volume, p. 154, Prof. Miall, speaking of the same subject, says an examination of the fossils of the Coal-measures, apart from marine bands, gives a result strongly in favour of the fluviatile or terrestrial origin of the bulk of the Coal-measures; and in adopting this conclusion we have no difficulty to face, except that implied by the supposition that the Elasmobranchs were more largely fluviatile than in other periods."

To sum up then, on the whole, very little positive evidence can be brought forward on behalf of a marine habitat for these shells; while there is, to say the least, a fair amount of presumption that they lived under fresh-water conditions. It may be, however, that we have in the occurrence of *Carbonicola* and *Naiadites* with various marine forms at the base only of the Coal-measures, an example of a genus changing its habitat. It is probable that all molluscan forms were originally marine in habit, and that by modification and adaptation some few forms became able to exist in fresh water; and it is also probable that this adaptation took place at different times, and is even going on now,—to wit, the discovery of *Hydrobia Jenkinsi* in inland canals of late years, which shell had till that time been only known under estuarine conditions.

§ II. CRITICAL BIBLIOGRAPHY.

The literature of this subject, though scattered, is fairly extensive; but unfortunately authors have worked independently, and not consulted previous writings: and this fault is much more marked amongst the Continental palæontologists, some of whom, writing within the last thirty years, have ignored all the work done in Great Britain; and, failing to grasp the number of varietal forms which the shells under notice are capable of assuming, have described each small variation as typical of a different species.

1720. The earliest literary trace of these Coal-measure shells that I am able to discover goes back as far as 1720, in a work entitled 'Memorabilia Saxioniæ Subterraniæ," by G. F. Myles, published at Leipzig, a work of high artistic and palæontographical value in the accuracy and detail of its many plates of fossil plants and prehistoric remains. Only one plate, however, refers to the subject of the present memoir, pl. xxvi, figs. 1, 9, 10, with a short description at p. 39, which I here transcribe. The quaint mingling of Latin and German, and reference to the Unio-like character of the fossils, are of interest:

Fig. 1. "Patellæ seu conchæ pictoriæ werden darum die auf diesen Stein sie præsenterenden Muschelen genennt, weil sie der Mahler gar sehn zu gebrauchen pflegen, daher sie auch in L. 17, ff. de instr. et instrum. leg. als instrumenta pictorum angeschen werden. Nicht weniger finden sich auf diesen Stein noch eine Art, welche Dactyli, germ. Känel-Nagel, oder Finger-Muscheln und Schalen heissen, deren Plinius, Lib. 9, cap. 61, gedenckt."

Fig. 8. "Die Muschel so allhier sich zeiget, ist gleichfals mit dem sub. fig. 1, erwehnten Dactylis zu vergleichen immassen auch die Selb."

Fig. 10. "In copia communicerten denen Patellis f. conchis pictoris, obschon nicht in dergleichen Grösse, über einkommen."

The former two figures refer to *Carbonicola*, the latter evidently to *Naiadites*. It is interesting to note in this earliest account the occurrence of these two genera together, and the reference of these fossils to Unio. It will be seen that the older writers on this subject were all of this opinion, and many Continental authors have continued to hold this view.

1793. From 1720 to 1793 I can find no mention of Coal-measure shells; but in that year the Rev. David Ure published his 'Natural History of Rutherglen,' a lasting testimony to his acuteness of observation and scientific mind. He describes certainly one shell now referred to *Carbonicola*, and possibly four. He says, p. 311, "The marble in Rutherglen . . . abounds in mussels. . . . Some entire specimens are enveloped in till" (? marl). He figures a specimen, pl. xvi, fig. 4, which has the appearance of the *Carbonicola aquilina* of later authors;

and I am the more inclined to this view from the examination of a specimen from that locality in the possession of Dr. John Young, Curator of the Hunterian Museum, Glasgow. About the figures, pl. xvi, figs. 5, 6, I must say I have great doubt as to the shells they are intended to represent. Ure says, "Two species of mussel are found in Kilbride: those of the former are casts and rare; the latter are in ironstone and lie flat." The former is possibly *Naiadites*, the latter *Lingula*. He figures on pl. xv, fig. 2, a shell which more closely resembles *Anthracosia robusta* than anything else I know, of which he says, "The cockle is found very perfect in schists with Orthoceras, Encrinites, &c., at Black Craig and Thornley Bank." I have, however, never known *C. robusta* to be associated with marine forms in Scotland, and Mr. James Nielson tells me that *Carbonicola robusta* never occurs in this locality.

1809. The next to write on the subject appears to have been W. Martin, who brought out his 'Petrefacta Derbyensia' in 1809 at Macclesfield; and, although holding somewhat curious views of the true import of fossils, yet he was endowed with an acute observation. His figures and description are excellent; and his work is still a standard reference as containing the first descriptions and figures of many Carboniferous Limestone species. He seemed to consider that each fossil species was but the representation in stone of living forms, as is shown in his description, where he states, "The hinge (visible only in recent species), &c." He figures three specimens from ironstone, and I feel no doubt as to the form represented. The name "Conchyliolithus (*Mya ovalis*)" is given to it. It is here to be noted that the *Mya* of Linnæus equals *Unio* of Lamarck.

1813. Sowerby, in 1813, published the vol. i of his 'Mineral Conchology,' containing a plate of Coal-measure shells, tab. xxxiii, figs. 1—3, 5—7, with short descriptions, pp. 83, 84, under the names *Unio subconstrictus* and *U. acutus*. The other figure on this plate (fig. 4) is said to have been obtained from marl at Felmersham, Bedfordshire, an Oolitic locality. I have examined the original specimen in the Sowerby Collection in the British Museum (Natural History), South Kensington, and, from the matrix and characters, consider it to be a well-known Oolite shell; but, curiously enough, this Oolite shell, called *Unio uniformis*, was considered by Sowerby to be the same form as Martin's *Mya ovalis* from the Coal-measures of Derbyshire, and the name was substituted because the former was in use for recent shells.

1824. Defrance, in the 'Dictionnaire des Sciences naturelles,' vol. xxxiii, p. 295, in 1824 followed Sowerby, but suggested that, as nothing of the interior was known, the genus was doubtful, and that the various forms described were simply variations.

1828. Fleming, in his 'History of British Animals,' 1828, quotes *Unio acutus*, Sow., giving, however, the locality as Middle Oolite, and *Unio Urii*, referring

Martin's shell to this form. He also quotes *Mytilus crassus*, referring to his previous note on this form, as *Modiolus*, sp., in the 'Edinburgh Philosophical Journal,' vol. xii, 1825, p. 246.

1829. H. Bronn, "Verzeichniss der im Heidelberger Mineralien Komptoir," &c. In 'Taschenbuch für die gesammte Mineralogie' (Leonard's 'Zeitschrift für Mineralogie'), Jahrgang 1829, Bd. i, p. 76, 8vo., Heidelberg, 1829, is the following:

"363. ? *Unio carbonarius*, n.; ? *Mytulites carbonarius*, d."

That is to say, Bronn, in 1829, made Boné's species of *Mytulites* a *Unio*. Bronn, in his list, should have put "*Zeit. Leonard*" instead of "*Jb.*" d = Steinkohlen-Formazion.

1829. In the same year Höninghaus published a list of the fossils in the University of Bonn ("Verzeichniss der dem Museum der Universität, Bonn," &c., 'Petrefacten Sammlung'), mentioning at p. 17 *Mya tellinaria*, *Mya ventricosa* from Liége, *Mya minuta* from Camerberg, (*Mya?*) *Unio acutus*, Sow., from Bocheim, and *Mytilus crassus* (*Mya sulcata?*) from Werden.

1832. A. H. Dumont, in his 'Mémoire sur la Constitution géologique de la Province de Liége,' published in 1832, gives at p. 356 a list of fossils from the Upper Coal-measures, amongst which are—

	Locality.
Unio acutus, Sow. *Mya acuta*, Höninghaus.	Bougny; Jemeppe.
Unio subconstrictus, Sow. *Mya tellinaria*, Höninghaus. „ *ventricosa*, „	Le Val Benoit.

1834. Mammatt published his 'Geological Facts of the Ashby-de-la-Zouch Coal-field' in 1834, and alluded to beds full of *Mya ovalis*, figuring small portions and crushed shells on several plates; but none can be recognised owing to their fragmentary condition.

1835. Hibbert, in 1835, published his memoir on the Burdiehouse Limestone, figuring without description a shell from that bed as *Unio nuciformis*, of which, unfortunately, all trace has been lost.

1836. In 1836 W. C. Williamson alludes in the 'Philosophical Magazine,' vol. ix, p. 351, to a shell from the Spirorbis Limestone of Pendlebury as *Unio Phillipsii*, and, giving a detailed description but no figures, refers to Hibbert's work, and suggests the similarity of the two shells.

1838. In 1838 Dr. W. Rhind, of Edinburgh, issued his little book 'The Age of the Earth,' figuring on pl. ii, *c*, *d*, *e*, *f*, Unios from the Coal-shale of Polmont, Falkirk; figs. *a* and *b*, *Axinus Pentlandicus* (probably *Schizodus*), and fig. *g*, a modioliform shell, all from Woodhall, Water of Leith.

1839. In 1839 Murchison refers in his 'Silurian System,' p. 88, to a letter from Prof. Phillips, describing three Unios and one modioliform shell from Ardwick, the latter of which he figures, p. 84, fig. *c*, and gives a woodcut of *Unio acuta* on p. 105, fig. *e*, but he does not discuss further the nature of these shells. Prof. Phillips's letter is as follows:—"This is a small shell from the Spirorbis Limestone of Ardwick, and looks so like a young Modiola that I hesitate to call it Unio. Tumid shell with prominent beaks, smooth, but with lines of growth, short straight hinge. In the argillaceous beds associated with the limestones are three Unios. The most common of these is nearly elliptical, hinge-line deviates considerably from parallelism, with front ends in prominent angle, lines of growth strong, shell thin, beaks slightly prominent. Professor Williamson refers this to *Unio nuciformis* of Hibbert inaccurately. It occurs in red beds, above limestone, black bass, and underlying coal-measures.

"2nd Sp.—I have named *Unio linguiformis* (*U. Phillipsii* of Williamson), transversely elongated, three times as wide as long, hinge-line almost parallel to front lines of growth. Shell fine, thin, smooth. (Black bass.)

"3rd Sp.—*Unio rugulosus*, obliquely expanded, in semi-elliptical form, the hinge-line forming the diameter. Surface concentrically marked with broken undulations, showing radiations on posterior slope. Shell very thin, occurring in marls above limestones, black bass, and shale, beneath calcareous bands."

1833. Davreux, in his 'Essai sur la constitution géognostique de la Province de Liége,' published in 1833, remarks at p. 101, "Les Unios ou Myas, ou peut-être Lingulæ, se montre dans un grand nombre de nos Houillières. . . . Ces bivalves fluviatiles se trouvent toutes en toit des couches, et n'ont jamais un volume très considérable." He figures—

Unio acutus, Sow.,
„ *antiquus*, Sow., } pl. v, figs, 3, 4, 8,

the latter a very characteristic cast of the hinge.

1834. Prof. Phillips, in his article on "Geology" in the 'Encyclopædia Metropolitana,' p. 590, speaking of the bands of marine shells in the Lower Coal-measures of Lancashire and Yorkshire, says, "In the midst of this series of Gannister Coal two layers of these shells occur; one of them about the middle of the series, considerably above the 'Pecten Coal,' and the other near the bottom, considerably below that coal." This paragraph is quoted by Mr. Binney in two papers on the marine shells of the Lower Coal-measures, 'Manchester Geol. Soc. Trans.,' vol. i, p. 82; and vol. ii, p. 75.

1834—1840. Goldfuss published his 'Petrefacta Germanica,' p. 180, during the years 1834 to 1840, and he described and figured (tab. cxxxi)—

1. *Unio abbreviatus*, Goldf.
2. „ *utratus*, Goldf.
3. „ *tellinarius*, Goldf.
4. „ *subconstrictus*, Sow.

} From Liége.

„ *uniformis*, Sow.
„ *carbonarius*, Bronn.

} From Kusel.

It had evidently escaped his notice that Sowerby states that his *Unio uniformis* did not occur in the Coal-measures, and, in addition, there is not the slightest resemblance between these two forms, as was pointed out later by de Koninck, and the name *Unio Goldfussianus* was given by him to Goldfuss's shell. I believe it really belongs to the genus *Anthracomya*. Goldfuss's description of the genus is evidently given from recent specimens. He enumerates as characteristic a pearly interior, eroded (*abgerieben*es) umbones, cardinal lateral teeth; and he remarks that it is supposed because all recent forms inhabit fresh water that fossil forms indicate the same conditions, and that the Coal, Lias, and Oolite forms have been referred to this genus from external appearances, although their interiors are almost unknown. *Unio carbonarius*, Goldfuss, differs entirely from *Unio carbonarius*, Bronn. The originals of Goldfuss's figures are said to be in the museum at Bonn, but Professor Schlüter tells me that he has searched for the figured specimens, and they are not to be found. He states that there are a few named specimens, but so badly preserved and so fragmentary that no opinion can be based on them.

1840. It was in 1840 that Professor Prestwich published his paper on the Coalbrookdale Coal-field, in the Appendix of which James DeCarle Sowerby described and figured twenty species of bivalves from that district.[1] This paper was read, however, before the Geological Society on February 5th, 1834, and April 13th and 27th, 1836.

1. *Donax ? sulcata.*
2. *Venus ? carbonaria.*
3. *Nucula æqualis.*
4. „ *accipiens.*
5. „ *acuta.*
6. *Unio Urii.*
7. „ *Ansticei.*
8. „ *parallelus.*
9. „ *dolobratus.*
10. „ *modiolaris.*
11. *Unio phaseolus.*
12. „ *aquilinus.*
13. „ *centralis.*
14. „ *robustus.*
15. *Modiola carinata.*
16. *Mytilus triangularis.*
17. *Avicula quadrata.*
18. „ *modiolaris.*
19. *Pecten gentilis.*
20. „ *scalaris.*

Of these, Nos. 1 to 8, and 19, 20, are marine forms. *Unio Urii* is certainly wrongly referred to Ure's shell; for it belongs to quite a different genus, probably *Edmondia*, to which also *Unio Ansticei* and *U. parallelus* may be referred.

[1] 'Trans. Geol. Soc.,' 2nd series, vol. v, 1840.

Of the remaining shells named *Unio*, Nos. 9 and 10 are now referred to *Anthracomya* (Salter), Nos. 11 to 14 to *Carbonicola* (M'Coy), while Nos. 15, 16, 17, and 18, described as *Modiola*, *Mytilus*, and *Avicula*, are now referred to *Naiadites* (Dawson). The figures are good and very typical, except in the case of *Carbonicola robusta* and *Anthracomya dolobrata*, which are from imperfect specimens.

1842. In 1842 S. Stutchbury ('Ann. and Mag. Nat. Hist.,' vol. viii, p. 481) proposed the name *Pachyodon* for certain Liasic and other shells which possessed a peculiar hinge-tooth, but he did not include any Coal-measure shells under this denomination; and it was from external appearance only that later on Captain Brown considered that the Coal-measure Unios might belong to this genus.

1842. In 1842 appeared Agassiz' translation of Sowerby's 'Mineral Conchology,' in which he proposed the name *Cardinia* for the shells of the Coal-measures previously described as Unios, considering them to be related to certain Jurassic forms.

About the same year (1842) de Koninck described and figured nine forms in his 'Des animaux fossiles du bassin Carbonifère de la Belge,' only one of which (*Cardinia nana*), which Geinitz thinks[1] belongs to *Estheria*, was mentioned for the first time. I am told by Professor Dewalque, of Liége, that these specimens are in the museum of Cambridge, Massachusetts. They are as follows:

Cardinia acuta.	*Cardinia nana.*
„ *subconstricta.*	„ *abbreviata.*
„ *atrata.*	„ *tellinaria.*
„ *robusta.*	„ *carbonaria.*
„ *phaseolus.*	„ *ovalis.*

He follows Agassiz in referring these forms to *Cardinia*, and describes the shell in such a manner that it is evident he never saw an interior of a Coal-measure shell, and that he took his type from Jurassic specimens. The figure of *Cardinia robusta* is remarkable, and has apparently been drawn from Sowerby's type, which, however, is incomplete, so that the lines of growth terminate abruptly; but in the Belgian form the lines of growth are carefully curved upwards to end, as if naturally, in the posterior slope.

This form is not mentioned by any Continental author by name, and is only figured by Achepol under a different title,[2] and in that case is found in a different coal-field. De Koninck's figure of *Cardinia carbonaria* is very different from *Unio carbonarius*, Bronn, to which it is referred.

1843. Colonel Portlock, in his 'Geological Report on Londonderry,' p. 568, mentions a shell described as Unio ? figured pl. xxxviii, fig. 6, as a doubtful shell with a deep impression near the beak. It is, however, associated with marine shells,

[1] 'Neues Jahrbuch f. Min.,' &c., 1864, p. 654; see also 'Report British Association' (for 1887), 1888, pp. 68 and 69, where Ludwig's Permian *Cyclas nana* (1861) and de Koninck's Upper Carboniferous *Cardinia nana* (1842), which are distinct forms, are referred to the genus *Estheria*.

[2] Vide *infra*.

and probably belongs to the genus *Sanguinolites*, though it has somewhat the shape of *Anthracomya*.

1843. Morris[1] gives in his 'Catalogue of British Fossils,' 1st edition, 1843, under *Unio*, some of the shells described in Prestwich's memoir, *U. ? aquilinus*, *U. ? centralis*, *U. ? dolobratus*, *U. ? modiolaris*, and *U. ? Urii*; under the name *Cardinia*, *U. acutus*, *U. subconstrictus*, *U. ovalis*, *U. phaseolus*, and *U. robustus*; under *Modiola*, Sowerby and Prestwich's *Modiola carinata*; under *Mytilus*, Fleming's *Myalina crassa*, Sowerby and Prestwich's *Mytilus triangularis*; under *Avicula*, the same authors' *Avicula quadrata* and *A. modiolaris*.

1843–46–55–64–67. H. B. Geinitz, in 1843, in 'Gaea von Sachsen,' p. 66, gives the forms *Mya minuta*, *Unio carbonarius*, *Unio uniformis*, the last of which, in 1846 ('Grundriss,' &c., p. 443, pl. xvii, figs. 16, 17), Geinitz re-described as *Cardinia Goldfussiana*, probably because Goldfuss had not noted the fact that Sowerby's shell *Unio uniformis* was from Oolite beds; and again in 1855 ('Die Versteinerungen der Steinkohlen-formation in Sachsen' he gives a list of synonyms and references to date, and re-describes the species.

He describes in 1855 *Unio tellinarius*, of which he says, "The posterior part of this shell is very variable—in fact, I never saw such a specimen as Goldfuss figures. Mine resemble more closely the second form figured by de Koninck, and when flattened, *Cardinia phaseolus*." A new form, *Cardinia Freystenii*, pl. xxxv, fig. 7 *a*, A, here figured and described for the first time, appears to be a short truncate *Anthracomya*.

A very important paper by this author appeared in 1864 in 'Neues Jahrbuch,' &c., p. 651, which will be alluded to in detail further on, as it is a criticism on a work which had appeared just previously.

In 1867, in the 'Neues Jahrbuch f. Min.,' &c., p. 682, Prof. Geinitz figured and described *Anthracosia Weissiana* from the Saarbruck Coal-field. I have been able to examine, by the kindness of Prof. Geinitz at Dresden, the type specimen, which consists of impressions in a micaceous sandstone. The shell is probably

[1] In Morris's 'Cat. Brit. Foss.,' 2nd edit., 1854,

Under *Unio*—	Under *Myalina*—
Unio ? *aquilinus*, Sow.	*Myalina carinata*, Sow.
„ ? *centralis*, Sow.	„ *quadrata*, Sow.
„ ? *dolabratus*, Sow.	Under *Mytilus*—
„ ? *modiolaris*, Sow.	*Mytilus crassus*, Fleming.
„ ? *parallelus*, Sow.	„ *triangularis*, Sow.
„ ? *Urii*, Fleming.	Under *Avicula*—
Under *Myacites*—	*Avicula modiolaris*, Sow.
Myacites Ansticei, Sow.	„ *modioliformis*, Brown.

At p. 189, under *Cardinia*, those forms described as such in the previous edition are repeated; and in addition, under *Cardinia* (*Pachyodon*), all those described by Capt. Brown in the 'Ann. Mag. Nat. Hist.,' 1843 (see next page).

Anthracomya Williamsoni; but I have no doubt at all as to the genus, as there are portions showing casts of the hinge-line and posterior end. The peculiar wrinkling of the periostracum, so frequently seen in *Anthracomya*, is well shown in one specimen on the slab.

1843. In the 'Annals and Magazine of Natural History,' vol. xii, p. 390, 1843, Captain T. Brown figured and described under Stutchbury's name *Pachyodon*, as new, twenty-six forms from English and Scotch Coal-measures:

Pachyodon Gerardii.	*Pachyodon Smithii.*
„ *lateralis.*	„ *Embletoni.*
„ *sulcatus.*	„ *Heyii.*
„ *rugosus.*	„ *agrestis.*
„ *subrotundus.*	„ *similis.*
„ *bipennis.*	„ *turgidus.*
„ *Dawsoni.*	„ *nucleus.*
„ *nanus.*	„ *Blaydsii.*
„ *Rhindii.*	„ *Aldamii.*
„ *amygdalus.*	„ *antiquus.*
„ *exoletus.*	„ *transversus.*
„ *dubius.*	„ *Levidensis.*
„ *subtriangularis.*	„ *pyramidatus.*

Of these, I think *P. Gerardii* and *P. pyramidatus* may have belonged to *Schizodus;* and, owing to the fact that Captain Brown did not recognise the extent of variation of which this form of genus was capable of assuming, many of these names must be considered as synonymous; but, nevertheless, several well-marked species and varietal forms are in this paper figured and described for the first time: unfortunately the descriptions are meagre, and the original specimens cannot be traced.

1844. It was in 1844 that W. King proposed the name "*Anthracosia* for a group of Unionidæ characteristic of the Coal-measures" ('Annals and Mag. Nat. Hist.,' ser. 1, vol. xiv, p. 313, 1844), which he says he intended to describe in his 'Monograph of the Permian Fossils;' but nothing further is said by King on the subject[1] save the sentence quoted.

1844. In the same year and volume, p. 100, is an interesting and valuable paper by Mr. H. E. Strickland on the genus *Cardinia*. He points out that in 'Études critiques sur les Mollusques fossiles,' Agassiz, the author of the term, seems to regard *Cardinia* as exclusively confined to the Lias and Lower Oolite, and justly criticises de Koninck for classifying "those Coal-measure shells as *Cardinia*, and prefixing a definition of the genus, which seems to be chiefly copied from de Christol's definition of *Sinemuria;* and we may, therefore, conclude that de Koninck had not been able to examine the interior of the fossils which he

[1] Until 1856, in the 'Ann. Mag. Nat. Hist.,' vide *infra*.

describes." Mr. Strickland then points out the difference in the characters of the Coal-measure shells from those of *Cardinia*, and contends for a fresh-water habitat for the former.

1844. In the same year Dr. Garner gave some drawings in the 'Natural History of the County of Stafford,' pl. E, of Coal-measure shells from the North Staffordshire coal-field; but he neither named nor described them. Figs. 21, 22, appear to be *Naiadites modiolaris*; fig. 19, *Naiadites carinata*; figs. 20 and 23, three forms of *Carbonicola*.

1845. In 1845 Murchison, von Keyserling, and de Verneuil ('Russia and the Ural Mountains,' pl. xxi, fig. 9), and de Verneuil ('Paléontologie de la Russie,' pl. xix, fig. 10), described and figured *Unio Eichwaldianus* as a Coal-measure form, closely allied to *Unio subconstrictus*, Sow., and *Unio uniformis*, Goldfuss, shells which probably belong to two different genera.

In 1846 von Keyserling, in 'Petschoraland,' &c., described *Cardinia subparallela* from Coal-measures.

1850. In a memoir with the title of 'Mélanges paléontologiques,' part 1, published in 1850, P. de Ryckholt described and figured—

Cardinia atrata, Goldfuss (not figured),
„ *Hullosiana*, Ryckh.,
„ *colliculus*, Rhyck.,
„ *nucularis*,
„ *Toillieziana*, Ryckh.,
„ **lians*,
„ *uncinata*
„ **Omaliusianus*,
„ **ampetilicola*,
„ **cordolianus*,
„ *angulata*,

Cardinia Scherpenzeeliana, Ryckh.,
„ *salebrosa*, Ryckh.,
„ *macillenta*, Ryckh.,
Mytilus præpes,
„ *Wesemælianus*,
„ *Toillieziana*,
„ *Fontenoyanus*,
„ *ligonula*,
„ *fabalis*,
„ *Geinitzianus*,
„ *divisus*,

mostly from the neighbourhood of Mons, Liége, and Tournay; but those marked thus * were from Visé. Most of the forms described as *Mytilus* are young examples of *Naiadites*, but I think it possible that *Posidonomya Gibsoni* is included amongst them.

I have been to the Museums of Brussels and Liége, but have not been able to find the original specimens, although Professor Dewalque showed me many in his own collection named after Ryckholt; and at the former place there are also specimens with his name attached. It is highly probable that many of the forms named above are synonymous, and denote different stages of growth of the same shell. The name *Mytilus præpes* is given to *Anthracomya Williamsoni* (Bronn) at Brussels. With regard to those shells described as *Cardinia*, all the forms figured belong to *Anthracomya* except *C. Halloziana*, which is a *Carbonicola*. These *Anthracomyæ* are much embellished in the drawings, and

many of their names are synonyms, it being highly probable that many of these species are only varietal forms, or young. It is to be remarked that no mention is made by de Ryckholt of de Koninck's or any other person's previous work on the subject, save only one single specimen after Goldfuss.

1849. In 1849 Capt. T. Brown issued his 'Fossil Conchology,' in which he re-figured all those shells previously described and figured in the 'Ann. and Mag. Nat. Hist.' (*op. supra cit.*) he also gave copies of the figures of those Coal-measure forms figured and described by J. De Carle Sowerby (*op. supra cit.*), also of one form figured by Rhind, and those from the 'Mineral Conchology,' and in addition he described and figured *Unio littoralis* and *U. discrepans* from Low Moor, Bradford;

Avicula modioliformis, Water of Leith (Naiadites).
Modiola Williamsoni, Wakefield (Anthracomya), pl. lxxi, figs. 24, 25.
„ *subtruncata*, Wakefield (Naiadites), pl. lxxii, figs. 15, 16.
„ *curtata*, Wakefield (Anthracomya), pl. lxxii, figs. 19, 20.
„ *Robertsoni*, Newcastle-on-Tyne (Anthracomya), pl. lxxii, figs. 24, 25.
„ *Moorei*, Vale of Todmorden (Anthracomya), pl. lxxii, fig. 27.
„ *minuta*, Low Moor (?), pl. lxxii, fig. 29.

He drops the name *Pachyodon*, and returns to the old name *Unio*.

1851. J. W. Binney ('Manchester Lit. Phil. Soc. Trans.,' vol. x, p. 181, pl. i, figs. 1, 2; pl. ii, fig. 1) published a paper on some trails and holes found in Carboniferous strata which he thought might be due to molluscs, probably *Modiolæ*, from the shape of their casts.

1852. F. A. Quenstedt, referring in his 'Petrefactenkunde' to Coal-measure Unios, describes a "glatter Leiste unter der Ligament." (He figures *Anodonta lettica*, Quenstedt, pl. xliv, fig. 16, from the Lettenkohle of Gaildorf, which from its shape would appear to be *Naiadites*.)

1853. Isaac Lea, in his paper "On some New Fossil Molluscs in the Carboniferous Slates of the Anthracite Seams of the Wilksbarre Coal-formations," published in the 'Journal of the Academy of Natural Science of Philadelphia,' ser. 2, vol. ii, pt. 3, January, 1853, p. 203, pl. xx, figs. 1 and 2, describes and figures two new species of *Modiola*. *M. Wyomingensis* and *M. minor*, which occur with shells, which he provisionally places under *Posidonia*, and certain fish remains. *M. Wyomingensis* has apparently all the external characteristics of *Naiadites*, and, indeed, Lea compares his shell with *Modiola* (*Naiadites*) *carinata*, Sow. The figure of *M. minor* is that of a shell too fragmentary for comparison.

1854 and 1856. In 1854 McCoy ('British Palæozoic Fossils,' by A. Sedgwick and F. McCoy, p. 514) proposed the name *Carbonicola* for the Coal-measure Unios. Referring to King's proposed name *Anthracosia*, but supposing that King had given up his intention to make use of it (as he had not published anything further) McCoy gave a description.

1856. This description King pointed out, in a note (dated December 27th, 1855) appended to his paper "On Anthracosia, &c.,"[1] could not be accepted for his shell. He said, "A few days ago (December 22nd) I received from Professor Sedgwick, for the library of Queen's College, Galway, the Third Fasciculus of his 'Synopsis of the Classification of British Palæozoic Rocks,' in which I perceive that Professor McCoy has published a genus under the name *Carbonicola*. My friend evidently thinks it synonymous with *Anthracosia*, which he admits being aware that I intended describing. However, if the genus *Carbonicola* possess the characters diagnosed by Professor McCoy, it is clearly not the same as my *Anthracosia*, which does not possess lateral teeth. There are certain errors in the remarks under the genus *Carbonicola*, which it must be obvious to anyone that I am not called upon to correct; but it is otherwise with several interspersed through the work," &c., December 27th, 1855.

It is a curious fact that amongst the many hundreds of shells I have seen and examined from British and foreign Coal-measures none possess anterior or posterior lateral hinge-teeth, nor is there any specimen in the Woodwardian Museum at Cambridge, where Professor McCoy obtained his types, which answers to his description. I can altogether bear out Professor King's contention that, whatever the shell which Professor McCoy thought he was describing may have been, it could not have been an interior of one of the Coal-measure bivalves. Was he drawing from his knowledge of recent Unios, and, like Sowerby, de Koninck and later on Salter, stating what he thought probably would be seen if he obtained an interior?

Professor McCoy enumerated under his genus *Carbonicola* the following species:

Carbonicola acuta.	*Carbonicola subconstricta*, var. *robusta.*
„ *subconstricta.*	„ *turgida*, Brown.

He gave reasons for considering *C. robusta* as only a variety of *subconstricta*.

Professor King in his paper (*supra cit.*) gives a good description of the generic characters of *Anthracosia*, and shows reasons for considering that it belongs to the family *Unionidæ*. He gives figures of the hinges of *Anthracosia Beaniana*, and the exteriors of *Anthracosia acuta*, Sow., and *Anthracosia Smithii*, Brown.

The description of the hinge and teeth, as given by Professor King, is rather complex, and is the form of hinge which the species *Anthracosia aquilina* possesses. I shall, I think, show that King's *A. Beaniana* is one of the varietal forms of *A. aquilina*.

[1] 'Ann. Mag. Nat. Hist.,' ser. 2, vol. xviii, January, 1856, pp. 51—57, pl. iv.

1856. S. P. Woodward in his ‘ Manual of the Mollusca ’ placed the forms now known as *Carbonicola* under *Anthracosia* (King) as a subgenus of *Cardinia* (p. 470). He says these shells are associated with Nautili, Discinæ, &c., but gives no locality in which this association occurs.

In the reprint 1880 there is an appendix by Ralph Tate, in which (p. 71) *Anthracosia* and *Carbonicola* are placed as two distinct genera of the Unionidæ; he follows King and McCoy in the diagnosis of each genus. At p. 69 *Anthracoptera* is placed under the Mytilidæ, and at p. 80 *Anthracomya* is placed under the Myacidæ, Salter's description being followed in the two latter genera.

1855–9. In 1855 to 1859, d'Eichwald, in the ‘ Lethæa Rossica,’ described and figured—

Modiolopsis conspicua.
„ *tenuissima.*
„ *tenera.*

Cypricardia pumila.
Modiolopsis Teplofi, Verneuil.
Cardinia Eichwaldiana.

All of these, except the last, from their shape appear to be *Anthracomyæ*.

On March 8th, 1858, Messrs. F. B. Shumard and G. C. Swallow read a paper, “ Descriptions of New Fossils from the Coal-measures of Missouri and Kansas,” published in 1858 in the ‘ Transactions of the Academy of Science of St. Louis,’ vol. i, p. 198, in which are described *Mytilus Ottawaensis*, *Mytilus tenuiradiatus*, *Myalina Kansasensis*, and *Myalina recta* from the Coal-measures which agree very closely in character with *Naiadites*. Mention is also made in the list, p. 177, of *Myalina subquadrata* from Permian and Coal-measure beds of the Valley of Verdigris. I am unable to find the description, but the shell is, however, figured by Messrs. Meek and Hayden on p. 33 of their ‘ Palæontology of Upper Missouri,’ in which is also figured and described *M. aviculoides*, pt. 1, pl. ii, figs. 8 *a*—8 *d*.

1859–64. In 1859 R. Ludwig published in the ‘ Palæontographica,’ Band viii, pp. 33—38, “ Die Najaden der Rheinisch-Westphälischen Steinkohlenformation,” in which he figures and describes from that coal-field—

Unio securiformis.
„ *obtusus.*
„ *cymbæformis.*
Anodonta lucida.
„ *Hardensteinensis.*
„ *brevis.*
„ *cicatricosa.*

Anodonta procera.
„ *minima.*
Cyrena (Cyclas) rostrata.
„ „ *anthracina.*
„ „ *extenta.*
Dreissina laciniosa.

In 1861, in another paper entitled “ Süsswasserbewohner aus der Westphälischen Steinkohlenformation ” (‘ Palæontographica,’ Band viii, p. 182), he describes and figures—

Unio Lottneri.
„ *crassidens.*
„ *batilliformis.*
„ *Geinitzi.*
„ *atratus*, Goldfuss.
Unio angulatus, Ryckholt.
Cyclas elegans.
Dreissina Feldmanni.
„ *dilatata.*
„ *inflata.*

In 1861 ('Palæontographica,' vol. x, pp. 21 and 22), in his memoir on the fresh-water shells of the (Permian ?) Coal-formation of the Ural, Ludwig figures and describes *Anodonta* (*Anthracomya ?*) *Uralica* and *A. ? obstipa.*

In 1863, in another paper entitled "Die Paläontologie des Urals" ('Palæontographica,' Band x, p. 18, &c.), he mentions—

Unio tellinarius, Goldf.
„ *Goldfussianus*, Koninck.
„ *Thuringensis*, Ludwig.
Anodonta carbonaria, Koninck.
„ *ovalis*, Martin.
„ *angulata*, Rhyckholt.
„ *subparallela*, Keyserling.
Anodonta Eichwaldiana, Murchison, Keyserling, and Verneuil.
„ *tenera*, Eichwald.
„ *Uralica*, Ludwig.
„ *obstipa*, Ludwig.
Cyclas obuncula, Ludwig.
Unio lepidus, Ludwig.

Again, in 1863–4, this author published a paper in the 'Palæontographica,' vol. xi, pp. 166, &c., on *Unio pachyodon* and three other species from various formations; *Unio Kirnensis* (being a form from the Coal-measures near Kirn, which he says is very like *U. Goldfussianus*), *U. compressus*, and *U. fabæformis* from the Rothliegenden of Neurode. So that this author is responsible for twenty-three forms of *Unio* and four forms of *Dreissina* from the Coal-measures.

The genera *Unio*, *Anodonta*, *Cyrena*, and *Cyclas* may all be here considered as synonymous with *Carbonicola*, and the author gives no reasons for this subdivision of the genera.

The majority of the originals of these figures are in the Geological Museum at Dresden, and I was permitted by the kindness of Professor Geinitz to study them there. I will first quote Professor Geinitz on the subject of Ludwig's papers, which criticism appeared in 1864 as an addendum to a paper by Gümbel (to be quoted later on in its chronological order) in the 'Neues Jahrbuch f. Min.,' &c., 1854, p. 651, where he says, "On the whole, my conclusions upon the species of Unio and Anodonta from the Coal-measures and Dyas, which Ludwig has so carefully described, differ considerably from those of that learned author;" and he proceeds to show that many of the forms are the same. The chief thing to be noticed on comparing the originals with the drawings is the amount of invention and artistic embellishment which have made crushed and damaged specimens appear as perfect. In one case the fossil itself is invented, being only a concretionary mass (*Dreissina inflata*, 'Palæontographica,' Bd. viii, t. lxxi, fig. 10). Many of the different

forms assumed by the shells are the result of crushing or imperfection, and the general accuracy of the work may be judged from Taf. v, fig. 8, where the impression of the external surface of a shell is correctly shown by the lines of growth; but the learned author has invented the anterior and posterior muscle-scars on the outer surface of the shell, and found there the accessory adductor scar wanting throughout the genus, and has described them in the text. Further, certain swellings and prominences are said to be enlargements for the ovary, and characteristic of the female sex. In the figure showing the hinge-plate of *Unio crassidens* the greater part is drawn from the imagination; for the original specimen consists of two valves which have slipped on each other somewhat at the posterior end, and shows only the posterior half of the hinge-line. I have been unable to see the lateral anterior and posterior teeth described in the text and figured, but this point will be discussed in detail hereafter.

The total neglect (in three papers out of four) of all the work done on the subject, both on the Continent and in England, is to be regretted; as, from a careful comparison of the shells, I have no doubt that the species are to a large extent the same as those previously described and figured by others.

The following papers will not be all found in strict chronological order, for in many cases there are several papers on the subject by the same author, and in this case it has been thought better to group them together, so that each writer's views may be presented in as concise a form as possible.

1860. In the Geological Survey Memoir to Sheet 142, parts of the Counties of Clare, Limerick, and Kerry, on p. 13 is a note by Mr. W. H. Baily in which is a figure (fig. 4) of *Myalina Foynesiana* from the Coal-measures of Foynes Island, co. Limerick. The specimen occurs in black shale with a Goniatite, and several specimens of *Posidonomya*. The original specimen is in the Geological Survey Collection at Dublin. In a note in the Memoir explanatory of Sheet 137, p. 12, Mr. Baily says, "At Bilboa colliery in the four-feet bed of shale immediately over coal No. 3 (three feet, or old colliery coal), which contained but few plants, fresh-water or estuarine shells (*Myacites*) allied to *Unio*, having both valves united, were found in great abundance; . . . with these were other species of bivalves, having the shells compressed, belonging to the same genus and to *Myalina*.

1860–78. The publication of the 'Acadian Geology' in 1860 by Sir William Dawson is important, as the name *Naiadites* is there given in the Supplementary Chapter to embrace all those Coal-measure shells called Unio, Anodon, Modiola, &c., by various authors. He describes eight species, six of which are figured. In the second edition, 1868, and third edition, 1878, p. 204, the shells are again figured and described with Salter's names given in brackets, the author advancing good reasons for not accepting Salter's misnomer *Anthracomya*.

Naiadites (*Anthracoptera*) *carbonaria*, Dawson.
„ „ *lævis*, Dawson.
„ (*Anthracomya*) *elongata*, Dawson.
„ *arenacea*, Dawson.

Naiadites ovalis, Dawson.
„ *angulata*, Dawson.
„ *obtusa*, Dawson.
Anthracosia Bradorica, Dawson (p. 314).

I have, by the kindness of Sir W. J. Dawson, been allowed to examine a series of his specimens, and the result appeared in a joint paper before the Geological Society of London (read February 21st, 1894), 'Quart. Journ. Geol. Soc.,' vol. L, pp. 435—442, 1894.

1861. In 1861 appeared the first edition of Hull's 'Coal-fields of Great Britain,' which contained one plate, of which fig. 1 is said to be *Anthracosia robusta*; and in a very brief reference to the Mollusca, pp. 40 and 43, under the names *Anthracosia* (*Unio* of early authors) and *Modiola*, a few words are said as to the marine or brackish water habitat of these forms.

In later editions, 1873 and 1881, the original plate was done away with and a new one (to face p. 38) given, with *Anthracomya carinata* (*sic*, for *Anthracoptera carinata*), *Anthracosia centralis*, and *A. aquilina*.

Prof. Hull's views as to the habitat of these shells appears to have somewhat changed; he says, "*Anthracosia* (*Unio*), *Anthracomya*, and *Anthracoptera*, capable apparently of living in fresh-water lakes or brackish water estuaries."

A very valuable paper by the same author, bearing very little on the shells themselves, from which I have quoted freely above (pp. 2, 3), appeared in the 'Quart. Journ. Geol. Soc.,' vol. xxxiii, 1877, p. 613, &c., "On the Classification of the Carboniferous Series;" but I doubt whether any evidence which he has adduced on the strength of the shells in question is of much value, owing to the great confusion which has existed up to the present time with various authors as to the generic characters of the various forms.

1856–63. The first memoir of Mr. Salter which I can find on this subject, to which he paid some attention, appeared in 1860 as the "Memoir of the Geological Survey," 'The Iron Ores of Great Britain,' Part I, 1856. 'The Iron Ores of the North and North Midland Counties' contains only the casual remark that certain beds at Chesterfield ("dog-tooth rake") "are almost made up of fossil bivalves (*Anthracosia*)," which he refers to *Unio agrestis* of Brown. He says that the "Wallis rake" at Codnor Park, Butterley, is full of the same shell.

1861. In Part III, 'The Iron Ores of South Wales,' in 1861, he enters more fully into the subject, and gives the diagnosis of his new genus *Anthracomya*, describing and figuring—

Anthracomya Adamsii.
„ *pumila*.

Anthracomya subcentralis.
„ *senex*.

He figures also—

Anthracomya modiolaris.	*Anthracosia acuta.*
Myalina quadrata.	„ *aquilina.*
„ *modiolaris.*	„ *ovalis.*
„ *carinata.*	

He discusses at some length the salt or fresh-water habitat of these groups, and endeavours to demonstrate that the *Anthracosia* were allied to the Myacidæ, and were burrowers.

1862. The next year he published in the Appendix to the 'Geological Survey Memoir,' "The Geology of the Country round Wigan," 2nd edition, a figure of *Anthracosia robusta*, showing the hinge, and the diagnosis, with diagrammatic figure, of his new genus *Anthracoptera*, the *Myalina* of his previous memoir. The description is curious, because he affirms the existence of "an obscure tooth in the anterior part of the hinge-line," and founds his genus to include those aviculoid shells "which have not the striated hinge-plate of Myalina," a character which I have shown[1] they have. He apparently made a species (*A. Browniana*) by dotting in a characteristic outline to the figure of another shell. In the same year, in the Appendix to Part IV of the 'Iron Ores,' he gives lists of the twelve mollusca of the North Staffordshire Coal-field, and the horizons at which they occur, on the authority of Mr. John Ward, F.G.S., of Longton; and in 1864, in the Appendix to the 'Geological Survey Memoir: the Country round Oldham,' he gives lists and horizons of Unio forms from the Lancashire Coal-field. Later on, in his list of fossils in 'The Country round Bolton,' he mentions a new form, *Anthracomya sanguinolaria*, MS.; but there has been no other reference made to it, and it is impossible to ascertain now what was the particular form for which the name was intended. Mr. Salter gives also numerous other lists in subsequent Geological Survey Memoirs, but does not give in them any further contributions of importance to the subject.

1863. In 1863, however, in a paper "On some Fossil Crustacea from the Coal-measures and Devonian Rocks of British North America," in the 'Quart. Journ. Geol. Soc.,' vol. xix, pp. 79, 80, treating of Some Fossils from the South Joggins Coal-field, Mr. Salter figured and described *Anthracomya elongata* (fig. 1), *Anthracoptera carbonaria* (fig. 3, a different figure from that of Dawson's *Naiadites carbonaria*), and *Anthracoptera* (*Naiadites*, p. 78) *lævis* (fig. 2, and p. 80), substituting these generic names for "Naiadites" proposed by Dr. Dawson, but without description.[2]

Anthracomya elongata, p. 79, fig. 1.
Naiadites lævis, p, 79, fig. 2 (*Anthracomya*, p. 80)
Anthracoptera carbonaria, p. 79, fig. 3.
} *Naiadites*, Dawson, p. 80.

[1] 'Quart. Journ. Geol. Soc.,' vol. xlix, 1893, pl. vii, figs. 1, 2.

[2] On February 21st, 1894, a note "On the Genus *Naiadites* occurring in the Coal-formation of

1862. Mr. Thos. Wardle, F.G.S., contributed a paper on "The Geology of the Neighbourhood of Leek" to John Sleigh's 'Ancient History of Leek,' in which he gives lists of *Anthracosia* (Carbonicola), *Anthracomya*, and *Anthracoptera* (Naiadites) which occur in the beds of the North Staffordshire Coal-field, and on pl. iv figures two specimens of *Carbonicola acuta*, fig. 13, under the name of *Anthracosia robusta*. Fig. 14, as *Anthracomya*, resembles *A. pumila*.

1862. In April of this year Mr. George Wild read his paper on "The Fulledge Section of the Burnley Coal-field" before the Manchester Geological Society, subsequently published in vol. iv, pp. 180, &c., of the 'Transactions.' He gives accurate horizons for shell-bearing beds, but only mentions the specific names of two of them, *Anthracosia robusta* and *A. acuta*.

1865. Huxley and Etheridge enumerate several species in their 'Catalogue of the Collection of Fossils in the Museum of Practical Geology,' pp. 156—161, but mention no new forms nor give any descriptive details.

1864–82. H. B. Geinitz remarks on the paper by Gümbel, "Ueber das Vorkommen von Süsswasserconchylien am Irmelsberge bei Crock am Thüringer-Wald," in the 'Neues Jahrbuch f. Min.,' &c., 1864, p. 651, on the forms—

Unio tellinarius, Gold.,
„ *Thuringensis*, Ludwig,
„ *uniformis*, Goldfuss,
Anodonta phaseolina, *? Estheria*,
Unio crassidens, Ludwig,
„ *carbonaria*, Gold,
„ *Goldfussiana*, de Koninck,
Anodonta ovalis, Martin,

only inventing the doubtful form *A. phaseolina*. He criticises Ludwig's species, and considers many of the named forms as synonymous.

1882. Later again, in 1882, he published a new form from the Dyas, *Anthracosia stegocephalum* ('Nachträge zur Dyas,' Heft 2, 1882, p. 43, pl. viii, figs. 20, 21).

1865. Volpersdorf describes and figures a *Modiola*, sp., from Glatz County in beds with scales of *Rhizodus Hibberti*, in the 'Zeitschrift des Deutsch. Geol. Ges.,' vol. xvii, 1865, p. 276, pl. vi, fig. 6, which is doubtless *Anthracomya*.

1860. McChesney described *Myalina Swallovi* in his 'New Species of Palæozoic Fossils,' p. 57, issued in 1860, and with the illustrations to the same gives figures on pl. ii, figs. 6 *a*, 6 *b*: "I have not been able to obtain access to these papers, and quote the reference from Messrs. Meek and Worthen's 'Geological Survey of Illinois (Palæontology),' vol. ii, p. 341."

1860. In the 'Proceedings of the Academy of Natural Sciences of Phila-

Nova Scotia," by Sir William Dawson, was read before the Geol. Soc. London, in which he points out that some of the shells named by him *Naiadites* belong to the same genera as those subsequently named *Anthracomya* and *Anthracoptera* by Salter; and that consequently his name *Naiadites* has priority. He advances additional reasons for a fresh-water habitat of these shells. A note was appended by myself, in which I concurred in the substitution of the name *Naiadites* for *Anthracoptera*.

delphia' for 1860, p. 496, Messrs. F. B. Meek and A. H. Worthen publish a paper entitled "Descriptions of New Carboniferous Fossils from Illinois and other Western States," in which is described *Myalina recurvirostris* from the Coal-measures, Illinois.

1864. In the volume of the same Society for 1864 the same authors, on p. 246, describe *Pleurophorus subcostatus* from the Coal-measure of Illinois, which I believe to be from the description a form of *Anthracomya*.

1886. In vol. i of the 'Proceedings of the Chicago Academy of Sciences,' p. 18, is a paper by Messrs. F. B. Meek and A. H. Worthen entitled "Descriptions of Palæozoic Fossils from the Silurian, Devonian, and Carboniferous Rocks of Illinois and other Western States," in which they describe as new species *Anthracoptera ? fragilis* from the Keokuk division of the Subcarboniferous series and *Myalina meliniformis* from Coal-measures of Illinois.

1866. F. B. Meek redescribes and figures in the Report of the 'Geol. Surv. Illinois,' vol. ii, Palæontology—

Myalina concentrica, Meek and Worthen, pl. xix, figs. 3 *a*, 3 *b*, 3 *c*, p. 281.
,, *angulata*, pl. xxiii, figs. 7 *a* and *b*, p. 300.
,, *recurvirostris*, pl. xxvi, figs. 9 *a*—*c*, p. 334.
,, *Swallovi*, McChesney, pl. xxvii, figs. 1 *a*—*d*, p. 341.
,, *meliniformis*, Meek and Worthen, pl. xxvii, fig. 3, p. 343.

1868. In the 'Transactions of the Geological Society of Glasgow,' read February 8th, 1868, vol. iii, 1871, p. 96, is found a valuable paper entitled "On the Upper Coal-measures of Lanarkshire," by William Grossart, the object of which is to correlate the various beds by their fossil contents. He states, p. 102, "Of the genus *Anthracosia*, the species *A. acuta*, *A. aquilina*, *A. ovalis*, *A. centralis*, *A. phaseolus*, are found in most of the beds of Kiltongue coal, but no further. *Anthracomya modiolaris*, *Anthracoptera modiolaris*, and *A. carinata* prevail in most of the beds. . . . . *Anthracoptera quadrata* appears to have had a very limited range, being seldom, if at all, seen beyond the region of the Splint Coal." . . . . *Anthracosia rugosa* [evidently *robusta*] is first met with in the Drumgray Coal, all other species of the genus having now disappeared." This is the bed from which so many good specimens of *A. robusta* are obtained at Shotts. He appends the following note:—"The genus *Anthracosia* appears to be confined to the Upper Coal-measures of Lanarkshire."

In the same volume, p. 283, in a paper by Mr. Robert Craig on "The Carboniferous Basin of Dalry," mention is made of the occurrence of *Myalina crassa* at Roughwood, Lyonshield, and Broadstone.

1870. Römer described, in 1870, a little bivalve-like *Modiola* from the "Coal-group, Charlotte," near Czernitz, in the "Geologie und Paläontologie von Oberschlesien," foot-note to p. 76, and "probably identical with *Modiola*, sp.

(Volpersdorf, *op. supra cit.*). This shell occurs in the Coal-measures of Lancashire.

1870. In the 'Geological Magazine' for 1870 is a paper by Professor Rupert Jones on some "Entomostraca from the Coal-measures of South Wales." At p. 216 he notices some *Anthracomyæ* from the Ebbw Valley, and refers to the compressed *Anthracomyæ* in the Ardwick beds described by Phillips (*op. supra cit.*), and figures (figs. 3 and 18, pl. ix) are given.

1891. This author also refers generally to the Coal-measure bivalves in his Address to the Geological Section of the British Association at Cardiff, in 1891. At p. 17 he remarks, "There is great probability of these not being truly marine. They may have lived in the brackish waters of lagoons and creeks, in the black, muddy swamps, having some communication with the sea, and often or occasionally inundated with salt water."

1871. Messrs. Young and Armstrong brought out their work 'On the Carboniferous Fossils of the West of Scotland, for the Use of the British Association Meeting at Glasgow, 1871.' They give lists and localities, but describe no new forms. Their views as to the fresh-water habitat of the shells I have quoted above (p. 4).

1871. In 1871 Ferd. Stoliczka, in 'Palæontologica Indica,' vol. viii, p. 84, places *Anthracosia* under *Saxicava*, and writes, "Prof. King advocates the idea that *Anthracosia* is a genus of Unionidæ, but there can be little doubt as to its close relation to *Notomya*, and it is even difficult to distinguish some of the species generically. The ligamental area of *Anthracosia* much more recalls that of *Panopæa* and *Cyrtodaria* than that of any known Unionidæ, and as Salter distinctly asserts that it is a marine or brackish water shell, I think its classification in this place (*Saxicava*) may be the more correct one."

1873. The work was carried on in Scotland by Mr. Robert Etheridge, jun., his first paper on the subject appearing in the Appendix to the 'Memoirs of the Geological Survey of Scotland: Explanation of Sheet 23.' Here a stratigraphical list of the localities and beds containing Coal-measure Lamellibranchs is given, and a note is appended (p. 104) on the burrowing habits and affinities of *Anthracosia*; he says, "Specimens of *A. robusta* and *A. acuta* were obtained resting on their ventral margins at right angles to the bedding of the entombing matrix; but none were obtained in a vertical position burrowing, as we find is the case with recent *Mya truncata*."

1875. In the 'Annals and Magazine of Natural History,' series 4, vol. xv, 1875, p. 427, "Notes on Carboniferous Lamellibranchiata," he gives the bibliography of *Myalina crassa* (*Mytilus crassus* of Fleming), and discusses its generic relations, giving some excellent plates.

1877. In the 'Geological Magazine,' new series, dec. 2, vol. iv, June, 1877,

pp. 243, 244, Mr. R. Etheridge, jun., gives a bibliographical account and a full accurate description of *Anthracomya Phillipsii;* and describes and figures a new form, *Anthracomya Scotica*, which he compares with *Naiadites lævis*, Dawson (Salter), and *Unio nuciformis* of Hibbert.

1878. His next contribution to the subject was in 1878, in the ' Quart. Journ. Geol. Soc.,' vol. xxxiv, " On our Present Knowledge of the Invertebrate Fauna of the Lower Carboniferous and Calciferous Sandsone Series," read November 7th, 1877. He re-describes Salter's genus of *Anthracoptera*, and doubtfully gives a new species, *Anthracoptera (?) obesa* (p. 12), pl. i, figs. 12, 13, 14 (?). He also makes some additional remarks on *Myalina crassa*, and describes and figures another form as *Myalina sublamellosa*, pl. i, fig. 15; pl. ii, figs. 16, 17. A specimen, pl. ii, fig. 20, is also doubtfully referred to *Anthracosia nucleus*, Brown, and *Arinus Pentlandicus* (pars), Rhind.

1879–81. In 1879, in the Appendix to the ' Geological Survey Memoir Scotland,' Explanation of Sheet 31, full lists of localities of shells occurring in the district are given, unfortunately often without specific names ; and a new form of *Anthracoptera*, *A. tumida* is described (without a figure) from the " Edge Coal " series, and its specific characters discussed at p. 82. Again, in 1881, in his Address delivered before the Royal Physical Society of Edinburgh, on " The Palæozoic Conchology of Scotland," pp. 48, 50, and 53, the generic affinities and the habitats of the genera *Anthracoptera* (Naiadites), *Anthracomya*, and *Anthracosia* (Carbonicola) are discussed. He sums up, " *Anthracosia* was probably not a purely fresh-water genus, but of brackish water habit."

1875. In a valuable paper on the " Organic Remains of the Coal-measures of North Staffordshire," published in the ' Proceedings of the North Staffordshire Field Club and Archæological Society,' 1875, p. 184, Mr. John Ward, F.G.S., gives a list of the *Anthracosiæ*, *Anthracomyæ*, and *Anthracopteræ*, and a record of the horizons at which they occur. He describes no new forms, and figures none of the shells, but gives full references to his authorities. The paper contains a short discussion on the vexed question of habitat ; and he believes he has found *Anthracosia* in the vertical position in the " Cockshead Shale."

A fuller account appeared in his monograph, " Geology of the North Staffordshire Coal-field, ' Trans. N. Staff. Institute of Mining and Mechanical Engineers,' vol. x, part v, issued in 1890, and pl. i contains figures of—

Anthracosia robusta.
„ *acuta* (a fine interior).
„ *centralis ?.*
„ *aquilina ?.*
Anthracomya Adamsii.
„ *Adamsii* (allied to *A. modiolaris*).
Anthracomya modiolaris (*Anthracoptera*).
„ *carinata* (*Anthracoptera*).
Modiola lithodomoides, on the authority of R. Etheridge, sen. (*Anthracomya lanceolata*, Hind).

The notes of interrogation and remarks are my own, from a personal examination of the specimens figured.

One new form, "*Anthracomya Wardi*," is described by R. Etheridge, sen., as if that genus belonged to the *Myacidæ*. In the text which deals with the stratigraphy of the coal-field, the beds in which the various forms occur are carefully noted.

1878. Mr. G. H. Kinahan, M.R.I.A., gives in his 'Geology of Ireland' a plate (pl. iv) with two forms of Coal-measure bivalves from Bilboa, Queen's Co., which he names *Myacites fabæformis* and *Anthracosia Bilboensis*. I have seen examples of the latter in the Royal Museum, Dresden, which were collected from Bilboa by Dr. Geinitz, and which I recognise as *Anthracomya Williamsoni* (Brown).[1]

He quotes Mr. Baily as to the occurrence of bivalve mollusca in the various Irish coal-fields.

1880. In 1880 Dr. John Young read, January 13th, a paper, subsequently published in the 'Transactions of the Geological Society of Glasgow,' vol. vi, p. 223, for that year, entitled "Notes on some Carboniferous Lamellibranchs." He discusses and sums up in favour of the fresh-water habitat of the genera *Anthracoptera*, *Anthracomya*, and *Anthracosia*. He there chronicles his discovery of prismatic cellular structure in the shells of *Anthracoptera* (*Naiadites*).

1880. In the 'Palæontographica,' vol. xxvii, p. 109, is a paper by Dr. Hans Polig, under the curious title "Maritime Unionen." In this he advances the view that the *Anthracosiæ* of the Coal-measures, the *Unios* of the Triassic, and the *Cardiniæ* of the Jurassic form a natural group, connecting on the one hand the *Cyprinidæ*, and on the other *Najades*.

1880–83. 'The Niederrheinisch Westfällisch Steinkohlen-Gebirge Atlas' was published by Achepol during the years 1880 to 1883. This remarkable work is distinguished by having, instead of plates, photographs of the objects themselves. These photographs are often so imperfect, from bad arrangement of the light during the process of photography, and the objects themselves are so often fragmentary and indistinct, that little or nothing can be made out of them. Added to this, the inventive genius of the author as to species-making is excessive, and he describes and figures thirty-seven forms, thirty-two of which are said to be new, although he has adopted names which previous authors had given to different forms.

Anthracosia Goldfussi, Achepol. *Anthracomya Williamsoni.*
„ *tellinaria.*
„ *securiformis*, Ludwig.

[1] Since going to press I have by the courtesy of the Officers of the Geological Survey of Ireland been permitted to examine the specimens in the Dublin Museum. I consider that the forms labelled there as above are both of them *Anthracomya* closely allied to *A. Williamsoni*.

Conocardium fusiforme, Achepol.	Not to be recognised.
„ *elegans*, Achepol.	Evidently *Naiadites*.
Anthracosia Beyrichi, Achepol.	*Carbonicola aquilina*.
Terebratula planosulcata, Achepol.	*Naiadites ?* said to have umbones.
Anthracosia gracilis, Achepol.	Photography and figures too poor.
„ *caudata*, Achepol.	
„ *minor*, Achepol.	
„ *Schlüteri*, Achepol.	*C. acuta* in Supplement.
„ *batilliformis*, Lud.	
„ *Decheni*, Achepol.	*C. aquilina*.
„ *Serloi*, Achepol.	
„ *rectangularis*, Achepol.	*C. acuta*.
„ *Hauchecornei*, Achepol.	*C. aquilina*.
„ species ? Achepol.	Too fragmentary.
„ *minima*, Achepol.	
„ *Berendti*, Achepol.	*C. aquilina*.
„ *Fabricii*, Achepol.	*C. acuta*.
„ *Römeri*, Achepol.	*C. aquilina*.
„ *Harzii*, Achepol.	*Anthracomya*.
„ *crassa*, Achepol.	*Carbonicola robusta*.
„ *naviformis*, Achepol.	*Anthracomya ?*
„ *obtusa*, Achepol.	Not Ludwig.
„ *brevis*, Achepol.	*Anthracomya ?*
„ *cassiformis*, Achepol.	*C. turgida*.
„ *concentrica*, Achepol.	*C. aquilina*.
„ *conocardium*, Achepol.	*Carbonicola*, crushed.
„ *Geinitzi*, Lud.	*C. aquilina*.
„ *Lottneri*, Lud.	
Anthracosia ovalis, Achepol.	
Mytilus eduliformis, Achepol.	*Naiadites carinata*.
Anodonta angulata, Achepol.	*Anthracomya*.
Dreissena Römeri, Achepol.	*Naiadites carinata*.
„ *Schlüteri*, Achepol.	

The figures of specimens described as *Dreissina*, *Mytilus*, *Terebratula*, and *Conocardium* are evidently those of *Naiadites*. The figures given in the four supplemental plates are better, but no reference is given in these to the specimens. Looking critically through these plates, I can find little or nothing new.

The specimens figured as *A. Goldfussi*, *A. naviformis*, *A. brevis*, *A. Harzii*, and *Anodonta angulata* are evidently *Anthracomyæ*.

The real merit of the work lies in the careful record of the fossils (plants and mollusca) which each bed contains; and it is a great pity that more care was not taken to compare the shells with the superabundant forms already named. I have given by the side of the list the proper equivalents, as far as I can judge from the figures and descriptions.

1881. Mr. W. H. Baily, in the "Explanatory Memoir of the Geology of the Leinster Coal-fields," 'Geological Survey of Ireland,' 1881, on pp. 21 and 25 notes the occurrence of *Anthracosia Bilboensis* and *Myacites fabæformis*[1] in the Lower and Middle Coal-measures of and around Castlecomer.

1881. Professor A. von Koenen, of Göttingen, has an important paper[2] in the 'Zeitsch. Deutschen Geolog. Gesellsch.,' vol. xxxiii, 1881, p. 680, pl. xxvi, figs. 6, 7, in which he re-describes the hinge of *Anthracosia securiformis*, and points out that Ludwig overlooked the fact that the supernumerary muscle-scar is close to the hinge-line, and on this fact bases his view that the *Anthracosiæ* are related to *Cardiniæ*. With regard to a lateral tooth he says, "Als Seitenzahn deutbar eine stumppe Kante auf dem Schossrande der linken Klappe und in der rechten eine flache Furche vorhanden." His figures are typical of the hinge of *Carbonicola aquilina*, and agree well with King's figures (*op. supra cit.*).

1882. The 'Recherches sur les Terrains anciens des Asturies et de la Galice' of Dr. C. Barrois appeared in 1882. He refers to Coal-measure shells at pp. 334 and 335. He makes the pertinent observation that the forms referred to *Myalina* by Meek and Worthen (*op. supra cit.*) cannot be separated from Salter's *Anthracoptera*, and describes and figures *Myalina carinata* and *M. triangularis*; but does not recognise the fact that these forms have not the true myophores of *Myalina*.

He figures and describes a shell which he refers to *Pachyodon bipennis*, Brown; but his figure appears too angular to agree with the original drawing. There is also one new form described, at p. 343, as *Naiadites Tarini*, the figure of which (pl. xvii, fig. 14) is exceedingly like the shell I figured ('Quart. Journ. Geol. Soc.,' 1893, pl. x, fig. 13) as *Anthracomya lanceolata*. It is probable that the two shells may be of the same species.

1882. In the same year Dr. J. R. S. Hunter, of Braidwood, produced his paper ('Trans. Geol. Soc. of Glasgow,' March, 1882, vol. vii, p. 143, &c.) "On the Geology and Palæontology of Banhead, Bellfield, Coalburn, and Lesmahagow," with lists of fossils. He enumerates from the Middle Coal-measures (p. 150)—

Anthracoptera carinata.	*Anthracoptera quadrata.*
,, *modiolaris.*	*Anthracosia acuta.*

1888. The following British forms of *Anthracomya*, *Anthracosia*, and *Anthracoptera* are enumerated in Etheridge's 'Catalogue of Palæozoic Fossils, Britain,' 1888, p. 278, &c.:

[1] There is a misprint in the original, p. 25, of *fabæforonis* for *fabæformis*.

[2] "Ueber die Gattung *Anoplophora*, Sandberger (*Uniona*, Pohlig)."

Myadæ.

Anthracomya Adamsii.	*Anthracomya pumila.*
„ *dolobrata.*	„ *rugulosa.*
„ *modiolaris.*	„ *sanguinolaria.*
„ *Phillipsii.*	„ *Scotica.*
„ *subcentralis.*	„ *senex.*
„ sp. (Phillips).	

Unionidæ.

Anthracosia acuta.	*Anthracosia ovalis.*
„ *aquilina.*	„ *phaseolus.*
„ *centralis.*	„ *robusta.*
„ *lateralis.*	„ *subconstricta.*
„ *nuciformis.*	„ *turgida.*
„ *nucleus.*	„ *Urei.*

Mytilidæ.

Anthracoptera Browniana.	*Anthracoptera quadrata.*
„ *carinata.*	„ sp. (Salter).
„ *modiolaris.*	„ *tumida.*
„ *obesa.*	

1890. Mr. Charles Roeder, in "Notes on the Upper Coal-measures of Slade Lane, Burnage" ('Manchester Geol. Soc. Trans,' vol. xxi, p. 114, read December, 1890), gives a full description of these beds, many of which contain mollusca. With one or two exceptions, however, he gives no specific names.

1892. In the same volume (vol. xxi, p. 364, read December 8th, 1891) is a paper by Mr. George Wild, on "The Lower Coal-measures of Lancashire," of great value. He figures (pl. ii, fig. 7) a new angular species of *Anthracosia*, which turns out, however, to be *Schizodus carbonarius*.

He also mentions in his Catalogue at the end of his paper, *Anthracosia*, sp., like *Sanguinolites*, from the Mountain-mine roof, Shaw, near Oldham; and *Anthracosia aquilina*, from a bed thirteen yards below the same seam at Rishton.

1892. M. X. Stainier gives (in 'Annales Soc. Géol. de Belg.,' vol. xix, p. 2) a list of shells, referred to by previous authors, from beds in Belgium, with a few additional localities from his own knowledge.

1892. In 1892 appeared the work of Professor W. Amalizky, "Ueber die Anthracosien der Permformation Russlands,"[1] in which he reviews most of the literature bearing on the generic affinity of the Unio-like forms of the Coal-measures. He erects the group into a family, under the name of *Anthracosidæ*, and divides the family into five genera:

Anthracosia, King.	Cardinal teeth only.
Carbonicola, M'Coy.	Cardinal and lateral teeth.
Najadites, Dawson.	Edentulous forms.
Palæomutela.	New multidentate forms.
Oligodon.	

[1] 'Palæontographica,' Band xxxix, 1892, p. 125, &c.

Many species of each form are described from the Permian beds of Russia, but the work will be here more fully discussed under the observations on the genus *Carbonicola*.

1893. In 1893 he published a small paper in Russ and German, "Ueber süsswasser Lamellibranchiata aus den carbonischen Bildungen des Donetz Beckens," read before the Section of Geology and Mineralogy of the St. Petersburg Natural History Society; in this he gives a plate, figs. 1 to 7, showing the hinge apparatus of *Carbonicola*, M'Coy, and figs. 10 to 17 of *Anthracosia*, King.

1893. In the 'Quart. Journ. Geol. Soc.,' May, 1893, vol. xlix, p. 249, is a paper by myself on "The Affinities of *Anthracoptera* and *Anthracomya*," in which I attempted to delineate more fully the generic characters of each, and to describe and figure the known forms. Subsequent study has necessitated some few alterations.

Another short paper of mine is to be found in the 'Annual Report of the North Staffordshire Field Naturalists' Club and Archæological Society,' which, however, contains nothing beyond what is included in the previous paper.

In the 'Geological Magazine,' dec. III, 1893, vol. x, p. 514, is a note on the so-called *Myalina crassa*, Fleming, in which I point out the identity of the anatomical characters of the shell of *Myalina crassa* with those of *Anthracoptera* (*Naiadites*).

In the same volume, p. 540, is a note (with a woodcut) on a slab from the shale above the Kinderscout Grit, showing a piece of fossil wood surrounded by numbers of *Anthracoptera* (*Naiadites*), and to which they had evidently attached themselves with the byssus.

1893. Mr. J. F. Whiteeaves published a paper on some large Unio-like shells of the South Joggins in the 'Trans. Royal Society of Canada,' Sect. IV, 1893, p. 21, in which he discusses the question of the earliest occurrence of Unio in geological strata, and describes some very large new Coal-measure fossils as *Asthenodonta Westoni*, with two figures, from which their close generic relationship to *Carbonicola* is very apparent, the hinge resembling that of *Carbonicola aquilina*, and to this genus it will probably be one day referred.

When I went to look through the collection of Coal-measure shells in the Manchester Museum, Owens College, I found that Mr. H. Bolton, F.R.S.E., Assistant Keeper, had intended to work up the subject, and had already in MS. a portion of his paper. It was at first proposed that he should join me, and that we should issue a joint Monograph; but subsequently, with great generosity, he retired and left the work to me. I have to thank him for his self-effacement in this matter, and for his further kindness in looking over my specimens, MS., and proof sheets, and for several valuable observations which have been of great service to me in the preparation of the section on *Carbonicola*.

§ III. CARBONICOLA.

It is always a difficult matter to decide as to which characters in a group of shells are to be regarded as of definite generic or specific value. Classifications, though based on anatomical resemblances, are, as Herbert Spencer states, only "subjective conceptions which have no absolute demarcations in nature corresponding to them;" so that it comes to be almost a purely personal matter to decide on what forms shall be considered for utilitarian purposes as of specific rank, or what others shall only be estimated as varieties.

I have felt that it was necessary as an aid to determine the horizons of such important beds as those of the Coal-measures to give specific rank to any forms which seemed to be typical of a bed; in other cases, when in the same beds a series of varieties occurred, to include them under one species.

The great difficulty in the subject lies in the very variable shape and characters of shells from the same beds; and were it not for the fact that I have fortunately been able in nearly every case to study hundreds of specimens, I probably should have been tempted to double the number of named forms.

A larger amount of variation might have been expected to have occurred in forms of this group obtained from the different coal-fields, but as a matter of fact the local variation is far greater. Amongst fresh-water shells there cannot exist the means for that free intermixture and consequent maintenance of a more constant type which obtains with marine mollusca. They would of necessity be isolated by drainage systems; and it is difficult to see, in the absence of aërial animals, how any amount of dispersion could take place except by floods. It is difficult to account for excessive variation in gregarious organisms with an identical environment; and this tendency to vary would appear to be universal, from the large numbers of forms that have been described and named by previous authors.

The beds in which the bivalve mollusca of the Coal-measures occur are indurated marls, black shales, and ironstones; and in most cases the fossils have both valves preserved in a closed position, showing that they are in the place and position in which they lived. They generally lie with their long axes parallel to the lines of stratification; but there exist beds in nearly every coal-field composed of the crushed valves and *débris* of myriads of shells which appear to have been finally deposited after death of the animal, the valves being nearly all single, or if double, widely opened out flat. As a rule, the lower beds of the Middle Coal-measures (stage F of Prof. Hull) are the most prolific in molluscan remains. I can find no evidence of any shells, except a compressed *Anthracomya* (*A. Phillipsii*)

above the Spirorbis Limestone. These occur in North Staffordshire, in the Blackband Ironstones. In a downward direction these shells are rarely found below the Millstone-grit, or even in these beds except in Scotland, and perhaps the north of England; and this is probably due to the fact that in England the Yoredale and Lower Limestone series (stages A, B, and C of Professor Hull) are essentially and probably wholly marine; while in Scotland and the north of England marine appear to have alternated with fresh-water conditions.

ASIPHONIDÆ (Integropalliata).

Class PELECYPODA (Lamellibranchiata).

Family UNIONIDÆ.

Genus Carbonicola, *M'Coy*, 1855.

Synonyms :

Unio, Retzius, 1788.
Mya, Martin, 1809.
Unio, Sowerby, 1829.
Pachyodon, Brown (*non* Stuchbury), 1843.
Cardinia (in part), Agassiz, 1841.
— — De Koninck, 1842.
Anthracosia, King, 1856.
— Amalizky, 1893.
Naiadites (in part), Dawson, 1860.
Carbonicola, Amalizky, 1893.

Generic Characters.—Equivalve, inequilateral, ovate or elongated, umbones convex, raised above hinge-line, sometimes eroded, generally anterior, beaks more or less contiguous, and with well-marked oval lunette in front of them. Anterior part of shell broad and tumid, posterior narrower and slightly compressed. A shallow, oblique, broad constriction, most marked at lower border, is situated a little posterior to the middle of the shell in most species. Anterior border bluntly curved, posterior narrow, truncated, curved, or angulated.

Surface marked with coarse concentric lines of growth. Periostracum thick, often wrinkled. Ligament external. Shell closed all round, nacreous, with occasionally pearly nodules. Radiating lines.

Interior:—Pallial line simple. Anterior-adductor scar large, almost marginal. Posterior-adductor scar large. Scars of the anterior-pedal muscles are situated above and slightly behind the anterior-adductor impressions.

Hinge-plate triangular, thickened, variable, with or without cardinal teeth. No anterior or posterior lateral teeth.

Observations.—Much uncertainty has existed amongst previous observers as to the true generic character of *Carbonicola*, and this doubtless arose from the paucity of specimens showing the hinge-structure, and the very variable appearance of the specific forms. The general consensus of opinion has, however, been that *Carbonicola* possessed marked Unioniform characters, and that in them we have some of the oldest representatives of this family. The chief facts in support of this view are the association of these fossils with plant and reptilian remains, and the anatomical features of the shells. The more important of these are—the shell being composed of an internal or nacreous layer, and an outer or prismatic; the thickened and wrinkled periostracum; occasional erosion of the umbones; the plan of the hinge, though it differs much in detail from that of most Unios; the simple pallial line, and the arrangement of the anterior and posterior adductor scars; the frequent possession of an oblique shallow depression, commencing at the umbo and stretching backwards and downwards to the lower border; also the general shape of the shell. The points in which *Carbonicola* differs from modern *Unionidæ* are the position of the accessory-pedal scars; the frequent non-erosion of the umbones; and the great variation of the hinge-structure in the species.

I have been compelled to drop Prof. King's name of *Anthracosia* for two reasons:—1st, that in his original publication ('Ann. Mag. Nat. Hist.,' vol. xiv, 1844, p. 313) no description or figure of the characteristic features was given; 2nd, that although M'Coy's name of *Carbonicola* is accompanied by a partially erroneous diagnosis, and unaccompanied by figures, yet there is no doubt whatever as to what shells are described under this name; neither is there any question as to priority, the publication by M'Coy of the name *Carbonicola* was at once commented on by King in a letter which I have quoted *antea*, p. 21.

The form of hinge described by Professor King is not, however, typically characteristic of the genus, but is that form which obtains only, as far as I am yet aware, in *Carbonicola aquilina*. Unfortunately the original specimens are not to be found, unless a very fragmentary example showing the hinge, in the Museum of Newcastle-on-Tyne, labelled in King's handwriting, is one of them.

I am at a loss to account for the description of the hinge as given by Professor M'Coy ('Brit. Pal. Foss.,' p. 514), where he says that it consists of "one very

thick cardinal tooth in the right valve, diverging obliquely towards the posterior side, one long anterior and one long posterior lateral tooth;" and again under *Carbonicola subconstricta* (p. 515), "Casts show the thick cardinal tooth and slender elongate lamellar lateral teeth." I have never been able to see any indications of "slender elongate lamellar lateral teeth," though I have examined hundreds of specimens; and further, I cannot see them in the types and specimens figured by Ludwig, who also describes these teeth. Professor McKenney Hughes has kindly permitted me to study all the specimens of *Carbonicola* and allied shells in the Woodwardian Museum. There are amongst these specimens only two in which the hinge-plate is visible, one of which (Pl. VI, fig. 44), a portion of the right valve, has an oblique posteriorly diverging cardinal tooth just under the umbo, with a concavity posterior to it for the corresponding tooth of the left valve; in the other (Pl. VI, fig. 43) there is a different form of cardinal tooth, but in neither can I see any indication of lateral teeth. M'Coy further, in describing the hinge-characters of the different species of *Anthracosia*, assumed that his type was invariable—an assumption which could not have been based on observation, as may be seen by the various forms of hinge figured in the plates of this Monograph. I cannot help thinking that, having settled on the Unio-relationship of this group, the typical hinge was assumed from the observation of recent forms. The specimens described in M'Coy's work were all stated to be in the Woodwardian Museum, but no specimen existing there now has the characteristics described under the name *Carbonicola*. Unfortunately, Professor Amalizky, of Warsaw, has in his work on the Permian *Anthracosiæ* retained both *Carbonicola*, M'Coy, and *Anthracosia*, King, as genera of a new family *Anthracosidæ*, relying on the hinge-characters given by these authors as diagnostic features. He admits, however, that, owing to the absence of a drawing, it is impossible to know what M'Coy really meant by "lateral teeth;" but he considers that the forms figured and described by Ludwig, and now in the Museum at Dresden, demonstrate this lateral tooth. In another place, however, he remarks, "We must not forget that the difference between these two genera [*Anthracosia* and *Carbonicola*] is only quantitative," and proceeds to show that in a series of specimens the hinge varies extremely, so that it passes from that of the form which he calls *Anthracosia* into that which he calls *Carbonicola*. I am sorry to say that I consider the descriptions and drawings of Ludwig altogether untrustworthy. I made a special visit to Dresden with a view of testing Prof. Amalizky's statements, and was allowed by the kindness of Prof. Geinitz to examine in detail the types and figured specimens there. Prof. Geinitz had already raised doubts as to the value of many of Ludwig's species, but had said nothing about the inventive genius displayed in the manufacture of artistic drawings. Ludwig seems to have described any shell which varied in the smallest particular under a new name; while

unfortunately in his earlier publications totally ignoring the work already done in the subject by English, Belgian, and other geologists. The figured specimens are, with very few exceptions, crushed, poor, incomplete, or undeveloped from the matrix—conditions which have not appeared either in the drawings or the text. Not only does he see fit to divide the genus into *Unio*, *Anodon*, and *Cyrena* (*Cyclas*) without advancing any differential diagnosis, and these genera into many species, but he invents anatomical features in the hinge, and in one case (*Anodonta cicatricosa*) indicates, in a cast left by the outer surface of the shell, the anterior and posterior adductor-muscle scars, not having recognised that the specimen showed the impression of the external surface only. In another specimen a concretion has been mistaken and figured for a specimen of his *Dreissena inflata*.

I examined many specimens, both in Berlin and Dresden, of forms similar to those described by Ludwig, and in no one was I able to satisfy myself of the presence of lateral lamellar teeth; and, moreover, I felt sure that the species were similar to those which had been described by previous writers. Still it is possible that Professor Amalizky may be wrong in considering that Ludwig meant to describe lateral teeth as being present. In the latter's description of the hinge of his *Unio securiformis* (*C. aquilina*), of which the drawings are fairly correct, is found "Das stark entwickelte Schloss besteht aus einem am Vorderende sitzenden gefalteten Zahn und einer runden, langsgefaltteen Leiste oben und nach hinten." The question here arises as to the exact interpretation to be put on the word "Leiste," as to whether it is to be taken as indicating a lateral tooth, or being used to describe the hinge-plate, such a tooth not being present in the specimen, but the posterior part of the hinge being a flattened vertical plate, somewhat irregularly rounded, surmounted by a groove for the insertion of the ligament; further, in the description of the hinge of *Unio Lottneri* (*Anthracosia acuta*) the following expression occurs:—"Das Schloss besteht aus einem dicken, vorspringenden, gekerbten Zahne hinter dem Wirbel [anterior], und einer langen, flachen Leiste vor demselben" [posterior].

I am inclined to think that what has been mistaken for the posterior lamellar lateral tooth is the upper edge of the flat hinge-plate, which is bounded above by the longitudinal groove for the insertion of the external ligament; this upper edge of the hinge-plate, being below the level of the superior border of the shell, therefore becomes apparently very prominent. On this point Ludwig states, "Das Ligament (Schlossband) lag ausserhalb längs der Leiste," which, I think, bears out my view. The hinges of Ludwig's *Unio batilliformis*, *U. crassidens*, and *U. lepidus* are pure artistic inventions, and are in the original specimens either very incomplete or partially covered up by the opposite valve. Yet these figures and the descriptions are quoted by Professor Amalizky as intermediate forms.

Considering the great variation of hinge-structure which obtains in a single

species of *Carbonicola* from the Coal-measures, I think it very unwise to rely on minute differences of this structure for the differentiation of genera; for, if this were to obtain, it would be necessary to divide one or two *species* into several *genera*. Whatever amount of differentiation may have become permanent in Permian times, and therefore of generic value, it is impossible to judge, on account of not having such fossils from British Permian beds, and non-access to specimens.

Professor Amalizky unfortunately only figures in his first great work two forms of the hinge of *Anthracosia*, one of which is a fac-simile of King's original figure of *Anthracosia Beaniana;* the other is the hinge of *Anthracosia Venjukowi*, which, from the drawing, appears to have no structural relation to the former. It is a type I have never met with in Great Britain. With regard to the hinge of *Carbonicola*, fac-similes of Ludwig's drawings are given in seven out of the ten figures; one of the remainder being the reproduction of an excellent figure of *Anthracosia securiformis* (*aquilina*) by Koenen,[1] in which the long lamellar lateral tooth posteriorly is conspicuously absent. The original of this, I think, I have seen at Berlin. Thus Prof. Amalizky depends on the accuracy of the figures of others for the facts on which he bases his division of the genus. Furthermore, he has adopted Sir J. W. Dawson's name "*Naiadites*," which, as originally described, contained shells of the three genera, the majority unfortunately not being related to the forms for which Professor Amalizky has borrowed the name, the typical forms belonging to *Anthracoptera* and *Anthracomya* (Salter), for the former of which the name *Naiadites* is to be retained.[2] In addition, the forms placed by Professor Amalizky under *Naiadites* are often found in young specimens of *Carbonicola*, and may in a few cases be permanent in the adult. In a subsequent paper[3] Prof. Amalizky figures a number of hinges of *Carbonicola* and *Anthracosia*, indicating as the posterior lateral teeth of the former certain small irregularities, which do not, however, appear to merit the description of "long lamellar teeth." Certain markings are seen, however, in Pl. V, fig. 38, and Pl. VI, fig. 2; and it is possible that they may be indications of, or primitive attempts at, the formation of the lateral tooth, which has become well developed in more recent members of the *Unionidæ*.

An important consideration, which must not be passed over, is the fact that, apart from the supposed differences in the hinge-plate, there are no other characters which can be relied upon to determine between specimens of Professor Amalizky's *Carbonicola* and *Anthracosia;* and here in England it is very seldom that interiors can be seen. A generic division by this character would serve no good purpose; and in the majority of cases it would be quite impossible, when the hinge is not visible, to say to which genus the shell belonged.

[1] 'Zeitschrift Deutsch. Geol. Gesellsch.,' vol. xxxiii, 1881, p. 86, pl. xxvi, figs. 6 and 7.

[2] 'Quart. Journ. Geol. Soc.,' vol. l, pp. 435—442, August, 1894.

[3] Read January, 1893, before the Geological Section of the St.-Petersburg Nat.-Hist. Society.

In 1881 Professor Koenen gave a good description of the hinge-plate of Ludwig's *Unio* (*Anthracosia*) *securiformis* in the 'Zeitschrift Deutsch Geol. Ges.,' vol. xxxiii, p. 686, as follows: "Die rechte Schale von *Anthracosia* trägt unter resp. ein wenig hinter dem Wirbel einen dicken, stumpfen Cardinalzahn mit einer oder ein Paar Kanten und darunter eine ganz flache, mitunter gekerbte Einsenkung des Schlossrandes; die linke Schale eine breite, nur wenig gegen den hinteren Schalrand geneigte Einsenkung des hier stärker geschwungenen Schlossrandes, und darunter eine Anschwellung desselben, welche allenfalls als schwacher Zahn gedeutet werden könnte. Vorn scheint die rechte Schale über die linke überzugreifen. Hinten ist, als Seitenzahn deutbar, eine stumpfe Kante auf dem Schlossrande der linken Klappe, und in der rechten eine flache Furche vorhanden." There is doubtful mention made here of a posterior lateral tooth, which, however, I fail to see in either the figures or the specimen which I had the opportunity of examining at Berlin.

It is difficult to know what King meant by "umbonal ligamental fulcra." He and, later, Salter seem to have supposed that *Anthracosia* possessed an internal cartilage, which occupied a cavity in the hinge-plate; indeed, the latter states,[1] "It [*Anthracosia*] certainly had an internal ligament. This is shown in a fine specimen in the Geological Society's Museum." Amalizky combats this statement, thinking that the observation must be a mistake. I consider that the striated furrow below and posterior to the umbo is for the attachment of the anterior and thickened portion of the external ligament, the striæ in the hollow in well-preserved specimens being due to the continuation of the lines of growth over the upper edge of the shell; and this termination of the lines of growth in the groove for the ligament occurs all along the edge of the shell.

It would seem, from the transverse section of the shell shown on Pl. XI, fig. 2, that some cavity was at times left, in which an internal, or the anterior part of the external, ligament may have been lodged; and I have returned to this question at page 48.

Many attempts have been made to connect the *Carbonicolæ* with the *Cardiniæ*; but it is doubtful whether Agassiz, the author of the latter genus, ever intended to include in it the Coal-measure Unios. I have been unable to verify this point, as I have been unable to see the original memoirs on the subject. De Koninck and de Ryckholt referred the Coal-measure Unios to Agassiz's *Cardinia*, of which genus Woodward[2] considered them to be a sub-genus. Quite recently Polig[3] and Koenen[4] have sought to show a close relation between *Anthracosia* (*Carbonicola*) and *Cardinia*. The former, however, does not discuss the question of a fresh-water habitat,

[1] 'Geol. Survey Mem., Iron Ores of South Wales,' pt. 3, p. 227.

[2] 'Manual of the Mollusca,' edit. 1, p. 470, 1851–6.

[3] 'Palæontographica,' vol. xxvii, p. 121, 1880. [4] Op. supr. cit.

and writes of them as "maritime Unionidæ;" while the latter considers that the position of the accessory-muscle scar is diagnostic of *Cardinia*. But this is not so, for the position of this scar in *Carbonicola* is very different from that which obtains in *Cardinia*. In *Carbonicola* the scar is above that of the adductor, between it and the upper border of the shell; while in *Cardinia* the scar is internal to the adductor, and within the pallial area. Moreover the position of the anterior adductor is almost marginal in *Carbonicola*, and situated in the superior-anterior angle of the shell; while this is not the case in *Cardinia*. The hinge, too, in *Cardinia* is totally different from that of *Carbonicola*, and is described by Woodward[1] as "cardinal teeth, obscure, laterals 1—0, 0—1, remote, prominent." Zittel,[2] Steinmann, and Doderlein[3] still retain *Anthracosia* as a sub-genus of *Cardinia*. Salter[4] hazarded the view that *Anthracosia* (*Carbonicola*) might be allied to the *Myadæ*. He says, "*Anthracosia* was, I believe, a burrowing shell. Among beds, where these fossils were the only bivalves, I have seen bivalve burrows answering to them in size. It had certainly a thick and wrinkled epidermis, as the *Myadæ* have, and no eroded beaks as is common in *Unio;* but the pallial line was simple and the valves close."

I have never seen specimens of *Carbonicola*, except perhaps occasionally and accidentally so, in an erect or vertical condition in the shales; they all lie with their long axes parallel to the planes of the bed, and they are often covered with *Spirorbis;* both of which facts militate strongly against the view that they were burrowers. Indeed, I think that the characteristics of the *Carbonicolæ* show a close connection with lower forms, in the transverse articulating hinge-plate and the persistence of the striations formed by lines of growth both in the lunule and in the groove for the external ligament posterior to the umbo. The common occurrence of an oblique shallow constriction and sinuated lower border points to a byssiferous ancestor, and a probable line of descent from a Mytilus-like form.

With regard to the question of eroded umbones in *Carbonicola*, some authors have described such a condition. The first was Professor Prestwich, whose note on the point I have quoted before.[5] Goldfuss[6] stated that the umbones of his specimens were "abgeriebene," though this word does not usually carry the meaning of erosion, but rather that of polish by friction. Ludwig[7] also uses the term "mit abgeriebenem Wirbel," but I could not make out that his specimens had been eroded anterior to fossilisation. Still a large number of specimens from the roof of the Cockshead Seam of North Staffordshire exhibit unimpeachable

[1] Op. supr. cit.

[2] 'Handbuch der Palaeontologie,' vol. ii, p. 61, 1881.

[3] 'Elemente der Palaeontologie,' 1892, p. 265.

[4] 'Geol. Surv. Mem., Iron Ores of South Wales,' pt. 3, pp. 226, 234, 236, 1861.

[5] P. 5.

[6] 'Petrefact. Germ.,' p. 180

[7] 'Palaeontograph.,' 1859, Band viii, p. 33.

erosions (see Pl. IV, figs. 8—12). It is curious, however, that I have been able to make out this peculiar feature in no other species of *Carbonicola*, but erosion is present in similar forms from other localities; and this eroded condition of the umbones is by no means universal, even in the bed mentioned. I conclude that erosion would not take place provided that the periostracum remained intact, and also that the presence of sufficient $CaCO_3$ to neutralise the free carbonic acid in the waters in which these shells lived would largely prevent erosion. It is still, however, a matter of great uncertainty as to what is the real cause of erosion in Unios; and, indeed, in some localities they are not thus affected.

The nearly universal occurrence of truncate and somewhat ventricose varieties of each species suggests the question as to the possibility of the dicœcious character of these Coal-measure Lamellibranchs; this, of necessity, is a question which cannot be settled in the absence of all data, though Ludwig and Achepol have ventured so far as to describe certain tumidities in the upper and posterior part of specimens as due to the situation of the ovary—a somewhat unwarrantable assumption, judging from what is known of the sexual organs of the *Unionidæ*.[1]

It is interesting to note that similar variation of forms occurs in the species of *Anthracomya* and *Naiadites*

I have considered it unnecessary to raise *Anthracosia* to the dignity of a Family, as I think that of the *Unionidæ* to be sufficiently wide to embrace a genus which seems to present only one important difference from the other genera included in it, viz. the abnormal (*quâ Unio*) situation of the anterior-pedal muscle-scars.

1. Carbonicola robusta (*Sowerby*). Plate I, figs. 1—6; Plate II, figs. 1—6, 9—11.

Unio robustus, *Sow.* Trans. Geol. Soc., ser. 2, vol. v, pl. xxxix, fig. 14, 1840.
Cardinia robusta, *de Koninck.* Anim. Foss. Belg., 1842–4, p. 71, pl. ii, fig. 1.
Unio robustus, *Brown.* Foss. Conch., 1849, p. 181, pl. lxxxviii, fig. 16.
Carbonicola subconstricta, var. robusta, *M'Coy.* Brit. Palæozoic Foss., 1855, p. 515.
Non Anthracosia robusta, *Hull.* Coal-fields of Gt. Britain, 1861, pl. i, fig. 1.
— — *Salter.* Mem. Geol. Survey, Country round Wigan, Sheet 89, p. 37, fig. 2, 1862.
Non — — *Wardle.* Geol. of Leek, 1863, pl. iv, fig. 13.
Anthracosia crassa, *Achepol.* Niederrheinisch.-Westfälische Steinkohlen-Gebirge, Atlas, 1880—1883, Supp., pl. i, figs. 19, 20, 1880–83.
— caudata, *Achepol.* Ibid., Supp., pl. iii, fig. 49, 1880–83.
— robusta, *Ward.* Trans. North-Staffs. Inst. Min. Mech. Engineers, vol. x, p. 127, pl. i, fig. 1, 1890.

[1] Though generally said to have the sexes distinct, I have never by dissection been able to satisfy myself that such was the case in the Unionidæ.

Specific Characters.—Transversely triangular, tumid; anterior end rounded, excavated above by lunule; and its anterior-superior angle almost a right angle, and much below the level of the umbones. Posterior end is gradually compressed and bluntly pointed and narrowed from above downwards by a rapid descent of the superior border.

Umbones contiguous, situated at the junction of the anterior and middle thirds of the shell; swollen and prominent, forming the apex of the triangular shell. The posterior part of the hinge-line slopes rapidly from the umbones. External ligament is very prominent, and terminates abruptly; posterior to it is a V-shaped trench, becoming shallower and narrower posteriorly between the bevelled edges of the hinge-plates. Inferior border is bluntly rounded in front, straight or sinuate behind; in the latter case the posterior-inferior angle of the shell has a downward direction.

There is often a broad constriction posterior to the greatest tumidity of the shell, directed downwards and backwards.

Hinge-plate consists of three parts. Anteriorly there is an elongated triangular surface, bevelled slightly at the expense of its lower border, the upper border becoming slightly thickened into an elongated ridge, which forms the lower border of the lunule; this ridge terminates suddenly at a point just anterior to or beneath the umbo, and is excavated posteriorly by a broad concavity, deeper anteriorly, but becoming gradually shallower as it passes into the posterior part of the hinge-plate. This concavity extends from just beneath the point of the umbo to the inferior margin of the hinge-plate, which is lost in the depression. The concavity is transversely striate; the striæ appear to be continuous with those of the lunule, which dip down into it. Posterior to the concavity there is a broad plain vertical surface, elongated triangularly, bevelled at the expense of its upper border, which, narrowing as it passes backwards, becomes lost in the external surface of the shell at its superior posterior angle.

Interior normal. Anterior-adductor scar almost marginal, deep, and oval. Posterior-adductor scar shallow. Surface with fairly strong concentric lines of growth, which are contiguous anteriorly, becoming separated as they pass over the body of the shell, often with a slight sinuation posteriorly, when they become reflected at a rounded right angle, to be lost in the superior border along the groove of the external ligament. Shell thick.

	Pl. I, fig. 1.	Another specimen, Pl. II, fig. 1.
Length antero-posteriorly.	90 mm.	55 mm.
Dorso-ventrally . .	58 mm.	35 mm.
From side to side . .	42 mm.	20 mm.

Localities.—In the Upper Coal-measures of Scotland. Rankinstone Ironstone,

near Ayr, Dalmellington, Airdrie, Cummock and Shotts, and above the Drumgray Coal of Lanarkshire. England: Lower yard seam, Fulledge Colliery, Burnley. Above the Arley Mine, Lancashire. Middle Coal-measures, Pendleton, Lancashire. Lofthouse and Killingback-beds, near Leeds. Roof of Shale Coal, Wakefield. Brockwell Seam, Wylam, Northumberland. Above the Holly Lane and Bowling Alley, and 10-foot Seams. Shale above 4-foot Coal, Wetley Moor. Shale above Woodhead Coal, Froghall, all in the Lower Coal-measures of North Staffordshire. Coalbrookdale (Pennystone Beds). Alfreton, Tibshelf (small form), and Codnor Park, Derbyshire.

Observations.—Through the kindness of Prof. Prestwich I have been able to study and figure the original type-specimen, Pl. I, figs. 2, 2*a*, which apparently differs widely from Salter's type; but it was pointed out to me by Mr. H. Bolton, of the Manchester Museum, Owens College, that Prof. Prestwich's shell was crushed and incomplete, as was, indeed, shown in the original drawing, the lines of growth terminating abruptly without becoming reflected upwards to the superior border. A smaller form, Pl. II, fig. 3, kindly lent me by Dr. John Young, of Glasgow, approaches somewhat to the original figure, its posterior end not being developed. This I believe to be a young state of the shell, from the fact that a series of intermediate specimens can be shown. Pl. I, fig. 6, from the Braidwood Collection of Dr. Hunter, and Pl. II, fig. 3, another of Dr. J. Young's specimens, are such forms.

De Koninck's figure of this shell ('Les Animaux Fossiles de la Belge,' pl. ii, fig. 1) is like Dr. John Young's small specimen; but this species seems to be rare in the coal-fields of the Continent, as no other author, except perhaps Achepol ('Niederrh.-Westf. Steinkohlen-Gebirge, Atlas,' Suppl. 1, figs. 19, 20, *A. crassa*; and Suppl. 3, *A. caudata*), records its presence; and, except at Brussels, I have seen none in any museum abroad. M'Coy ('British Palæozoic Fossils,' p. 515), judging from Sowerby's figures of *Unio subconstrictus* ('Min. Conch.,' Tab. xxxiii, figs. 1—3; and *U. robustus*, 'Trans. Geol. Soc.,' ser. 2, vol. v, pl. xxxix, fig. 14), considered that the latter was only an adult form of the former, the figure of *U. robustus* appearing shorter and deeper than natural from the oblique fracture of the posterior end.

I have not seen very many hinge-plates of *C. robusta*; but, judging from those I have seen, this species seems to have possessed a more constant form than others. Mr. Salter figures a hinge-plate in the Appendix to the 'Geological Survey Memoir, the Country round Wigan,' which agrees very closely with Pl. II, fig. 9. In young forms the anterior part of the hinge-plate does not seem to be developed into a cardinal tooth to the extent which obtains in older specimens. In Salter's figure there is a little irregularity shown in the hinge-plate towards the posterior end: I have seen a similar condition in some of the interiors of other species of *Carbonicola*, and consider it to be the position of the

attachment of the posterior end of the external ligament, as is the case in the recent *Anodonta*.

The umbones of this species are seldom eroded. The only specimens in which I have seen this feature are from Codnor Park. One specimen from the Collection of Mr. Neilson, of Glasgow (see woodcut), appears to have been bored with a circular hole; and a similar hole is shown in one of Mr. Salter's figures (*op. supra cit.*). To what these holes are due it is impossible to guess, for Gasteropoda have never been found in the beds with *Carbonicola* (see also p. 74).

The pit for the reception of the cardinal tooth of the opposite valve is very large in the specimen figured, Pl. II, fig. 1 *a*, much larger than is necessary. The same feature may be observed in many of the valves on Pls. V and VI, and more particularly in the transverse section on Pl. XI, fig. 2. This raises a question as to the possibility of there having been present an internal ligament or cartilage lodged in this hollow, and the fact that striæ can be made out would also point to this conclusion; but this cartilage could not have been always present, as there is no room for it in many of the hinges figured on Pls. V and VI differing from that which I have considered to be the normal type. It is possible that this hollow lodged a process of the external ligament, which had here its anterior and strongest attachment. Whilst, however, on the one hand there are forms showing a slighter degree of development in the posterior end, there are others (Pl. II, figs. 1, 2), from Limerigg, Slamannan, in the collection of Mr. Smith, of Kilwinning, which show a more elongated shape, with much smaller comparative dorso-ventral diameter; but these have the characteristic constriction at the junction of the middle and posterior thirds of the valves, and the beaked posterior end.

This species is the largest form of *Carbonicola*, and is very much larger than other members of the genus. In England the large form has a very limited distribution, both horizontally and locally. It is much more common in Scotland; though, there, it appears to keep to one horizon. In the North Midlands of England there is a dwarf form, but generally obtained crushed.

The shape is very characteristic; the comparatively great dorso-ventral depth and the tumidity in the anterior half of the shell are of diagnostic importance. Salter considered the form to be identical with *Unio rugosus* (*Pachyodon*, Brown).

2. Carbonicola rugosa (*Brown*). Plate II, figs. 7, 8, 8 *a*.

Pachyodon rugosus, *Brown*. Ann. Mag. Nat. Hist., vol. xii, p. 391, 1843.
Unio rugosus, *Brown*. Foss. Conch., pl. xv, figs. 6, 7 ; pl. lxxiii, figs. 14, 15, 1849.

Specific Characters.—Subtriangular, ventricose. Umbones massive, subcentral, obtuse, tumid, incurved, and contiguous. Anterior end swollen ; anterior border rounded, meeting the superior border at an angle rather greater than that of a right angle. Posterior end swollen ; the superior border slopes rapidly downwards, forming a bluntly-curved posterior border. Inferior border uniformly convex.

Lunule broad, deep, and well marked. Ligament large, erect, extending from between the umbones half the length of the posterior hinge-line.

Valves uniformly convex, covered with fine striæ and rugæ of growth. Interior unknown.

Dimensions :	Antero-posteriorly.	Dorso-ventrally.	Laterally.
Mr. Wild's specimen	62 mm.	48 mm.	42 mm.
Specimen in Geol. Survey Mus. (incomplete)		48 mm.	41 mm.

Localities.—Ironstone, Hebden Bridge, Cant-Clough, Burnley,—horizon doubtful.

Observations.—This form appears to be allied to *C. robusta*, to which Mr. Salter ('Geol. Surv. Mem., Wigan,' p. 37, 1862) was inclined to refer it. But there are certain characteristics, as the more central position and the shape of the umbones, the deep elongated lunule, and the comparatively greater tumidity of the shell, which, taken in connection with the different horizon at which the shell occurs, have induced me, for the present, to retain Captain Brown's name. His original specimen is said to have come from the Hebden Bridge Ironstone, and the figure given is that of a perfect specimen ; but I have been unable to trace it.

I only know of two specimens, both from the neighbourhood of Burnley, and these have been kindly lent me to figure by the Director-General of the Geological Survey and Mr. George Wild, but unfortunately both of these specimens are imperfect posteriorly.

The exact horizon of these specimens is doubtful, but it is certainly low down, possibly Yoredale. Mr. Wild writes me that he has no notes of the bed from which he obtained his specimen. That belonging to the Geological Survey Collection is labelled "Coal-measures."

3. Carbonicola acuta (*Sowerby*). Plate III, figs. 1—12; Plate IV, figs. 8—17; Plate V, figs. 1, 3—37, 39; Plate VI, figs. 1—43.

Unio acutus, *Sow.* Min. Conch., vol. i, p. 84, pl. xxxiii, figs. 5, 7, 1829.
— — *Defrance.* Dict. Sci. Nat., vol. xxxiii, p. 294.
— — *Hoeninghaus.* Verzeichniss Petrefact. Sammlung, 1829, p. 17.
— — — Neues Jahrbuch, 1830, p. 240.
Non — — *Dumont.* Géol. Liége, 1832, p. 356.
Non — — *Davreux.* Essai sur la constit. géolog. Liége, 1833, p. 101, pl. v, figs. 4, 8.
— — *Murchison.* Sil. Syst., 1839, p. 105, fig. c.
— tellinarius, *Goldfuss.* Petrefacta Germaniæ, 1834–40, vol. ii, p. 180, pl. cxxxi, fig. 17, 1840.
Cardinia acuta, *de Koninck.* Carb. Foss. Belg., 1842, p. 75, pl. I, fig. 8.
— — *Agassiz.* Translation Sow. Min. Conch., 1842.
— tellinaria, *de Koninck.* Carb. Foss. Belge, 1842, p. 77, pl. I, fig. 14; pl. H, fig. 5.
Pachyodon exoletus, *Brown.* Ann. Mag. Nat. Hist., vol. xii, 1843, p. 392, pl. xvi, fig. 4.
— antiquus, *Brown.* Ibid., p. 394, pl. xvi*, fig. 4.
— transversus, *Brown.* Ibid., p. 395, pl. xvi*, fig. 5.
— Levidensis, *Brown.* Ibid., p. 395, pl. xvi*, fig. 8.
— agrestis, *Brown.* Ibid., p. 393, pl. xvi, fig. 11.
Unio tellinarius, *Garner.* Nat. Hist. Staffordshire, 1844, p. 452, pl. e, fig. 23 (no name nor description).
— senex, *Brown.* Foss. Conch., 1849, p. 178, pl. lxxiii, fig. 31.
— agrestis, *Brown.* Ibid., pl. lxxiii, fig. 20.
— transversus, *Brown.* Ibid., pl. lxxiii, fig. 21.
— Levidensis, *Brown.* Ibid., pl. lxxiii, fig. 30.
— exoletus, *Brown.* Ibid., pl. lxxiii, fig. 25.
Carbonicola acuta, *M'Coy.* Palæozoic Fossils, 1854, p. 514 (description only).
Anthracosia acuta, *King.* Ann. Mag. Nat. Hist., 1856, ser. 2, vol. xviii, pl. iv, fig 5, p. 57.
Unio Lottneri, *Ludwig.* Palæontographica, vol. viii, 1860, p. 183, pl. lxxii, figs. 1, 1 *a*, 2.
— tellinarius, *Ludwig.* Ibid., vol. x, 1861, pl. iii, figs. 4 *a—d.*
Anthracosia acuta, *Salter.* Geol. Surv. Mem., Iron Ores of South Wales, 1861, pt. 3, pp. 226 and 228, pl. ii, figs. 20, 21.
Non — — *Rœmer.* Lethæa Geognostica, 1876, pl. xliv, fig. 9.
— securiformis, *Achepol.* Niederrheinisch.-Westfälisch. Steinhohlengebirge, Atlas, 1880–83, p. 47, pl. xiii, figs. 3—6.
— — — Ibid., p. 59, pl. xvii, fig. 3.
— — — Ibid., Suppl., pl. iii, fig. 1.
Cardinia tellinaria, *Achepol.* Ibid., pp. 40, 41, pl. xi, figs. 4, 9.
Anthracosia gracilis, *Achepol.* Ibid., Suppl., pl. iii, figs. 38, 39.
— rectangularis, *Achepol.* Ibid., p. 86, pl. xxvii, figs. 1, 2.
— — — Ibid., Suppl., pl. iv, fig. 12.
— Fabricii, *Achepol.* Ibid., pp. 119, 120, pl. xxxvi, figs. 5, 11.

Anthracosia Fabricii, *Achepol.* Niederrheinisch.-Westfälisch. Steinhohlengebirge, Atlas, 1880–83, Suppl., pl. iv, figs. 61, 62.

— Römeri, *Achepol.* Ibid., p. 136, pl. xli, figs. 1—20.

— acuta, *Ward.* Trans. N.-Stafford. Inst. Min. and Mech. Engineers, vol. x, p. 128, pl. i, fig. 8, 1890.

Specific Characters.—Shell elongate, transversely ovate, tumid; anterior end short, bluntly rounded, swollen. Posterior end produced, gradually compressed and narrowed by the approximation of the superior and inferior borders, with a more or less acutely pointed posterior-inferior angle, above which the border is obliquely truncate. Hinge-line straight, about two-thirds the length of the shell. Umbones gibbous, broad, fairly prominent, not contiguous; beaks deflected very slightly forwards, situated at the junction of the anterior and middle thirds of the shell. Lunule elongated, and, when both valves are together, ovate; striated above by the lines of growth curving round and becoming reflected into the inner face of the umbo; smooth and plain for a narrow space along the edge of the hinge. Neutral margin bluntly rounded anteriorly, the curve being continuous with the anterior border; at about the centre of shell it becomes straight, very slightly sinuous, and directed upwards. On each side of the posterior part of the upper border, which is somewhat erect, the shell becomes slightly constricted longitudinally. Cartilage external, extending about half the length of the hinge-line.

Shell thick, almost massive at umbones. Surface with coarse irregular concentric lines of growth.

Anterior- and posterior-adductor scars deep; the former almost marginal, containing at times pearl-like growths.

The hinge apparatus is very variable; but three distinct types may be recognised, which I purpose describing as α, β, and γ. These different forms occur in the same bed, and are connected by transitional forms.

Form α (Pl. V, figs. 1 and 3—16).—The hinge-plate may be divided into three portions. In the right valve anteriorly there is an elongated triangular surface, which may or may not be bevelled and facetted at the expense of the lower border. The superior border is slightly thickened or ridged to form the cardinal tooth, behind which is a broad concavity, becoming shallow posteriorly, when it passes into a broad vertical smooth plate, which rapidly narrows, to be lost on the inner surface of the shell near the posterior end. In the left valve anteriorly the lunule passes into an elongate concavity, while there is a more or less marked lip below the lunule and anterior part of the depression, smooth or facetted, and at times bevelled at expense of upper border. Posterior to this concavity, which terminates abruptly, is a thickened boss, the cardinal tooth, which may or may not be separated from the posterior part of the hinge-plate by a depression, which receives an accessory tooth, if one be present in the right valve. The posterior

part of the hinge-plate is smooth and vertical as in the right valve, and slightly bevelled from below upwards.

The form β, Pl. V, figs. 17—34, has lost the simple character of right-valve tooth anterior, socket posterior, and left-valve socket anterior, tooth posterior, and has in the right valve its anterior portion much bevelled at the expense of its lower border; while the upper border of the hinge-plate is raised into a long irregular tooth, which extends considerably behind the umbo, and has, posterior to it, a narrow wedge-shaped depression, with apex upwards, to receive the tooth of the opposite valve.

The posterior part of the hinge-plate is as in the form described above. The great feature here is the absence of the broad depression in the right valve below the umbo, and in the left valve anterior to it.

In the left valve, anteriorly, the lower part of the hinge-plate is produced, while its upper border is reduced, and becomes hollowed longitudinally to receive the elongated tooth of the right valve, behind which is an elevated collar sloping backwards, against which the tooth in the right valve rests.

The posterior part of the hinge-plate is rarely a plain surface; at times it is twisted on itself, and may be excavated in places, as in recent Unios, for the attachment of the posterior extremity of the ligament. The form of lock is vertical, the tooth of right valve being superior to that of the left.

It has, I think, from the observation of transitional forms, been evolved by the elongation backwards of the tooth of the right valve, encroaching on the concavity for that tooth in the left, causing a corresponding atrophy of that tooth; at the same time, a bevelling of the lower part of the anterior portion of the hinge-plate of the right valve, and a corresponding increase in the lower part of the anterior portion of the left, took place.

The third form, γ, Pl. V, fig. 37, differs from the type β in having in the right valve the one long cardinal tooth bifid, with a triangular pit between the two portions. The left one has a single median cardinal tooth, with a concavity in front and behind it. The vertical locking arrangement, by bevelling the edges of the hinge-plates of the respective valves, is as in form β, so that in form γ a much stronger lock is obtained, having both a vertical and horizontal articulation. Occasionally I have met with a transposition of the hinge arrangement, the cardinal tooth then being anterior, and overlapping that of the right (Pl. V, fig. 7).

Dimensions:

Antero-posteriorly . . .	54 mm.
Dorso-ventrally . . .	28 mm.
Laterally	20 mm.

Localities.—England: Yard-coal, Chesterton; Cockshead Coal-roof, Adderley Green; Ten-foot Coal, Bucknall; Banbury Seam, Bucknall; Knowles Bass, Longton;

Bowling Alley, over Four-foot Coal, Wetley Moor; N. Staffs Coal-field; above the Broach Coal, Dudley; Middle Coal-measures of Bolton, Bury, and Oldham; Coal-measures, Nottingham; Unston, Derbyshire. South Wales: Rosser Vein, Cwm Bryn ddu, Jack mine, Cwm Aman. Blue Vein, Gantre; Bottom Vein, Sirhony. Stanley Main; Wakefield; Sheden; Lowmoor, Middleton; Band, near Townelly Seam, West Wylam. Eltingham Colliery, Prudloe; Northumberland and Durham Coal-field. Scotland: Kilmarnock; Shotts; Airdrie, Shettleston, U. C.-m.; Eight-foot Coal, Scoonie; roof of Eight-foot Seam, Durie Colliery; Fifeshire Coal-field.

Observations.—This species has a wide distribution, both horizontally and vertically. Its form, however, as might have been expected, varies considerably. The type form (Sow.), Pl. III, fig. 1, is perhaps the most common, but the varieties do not seem to be due to local or horizontal environment. I find them all occurring in numbers in the roof of the Cockshead Seam of the North-Staffordshire Coal-field, with members of an intermediate form, indicating the lines of variation. In many specimens there exists a feature denied to this species by M'Coy, namely, a subconstriction or oblique sulcus, widening as it approaches the ventral border, and showing a close relationship to similar forms of *C. robusta*, with the smaller elongated form of which shell, indeed, *C. acuta* is closely allied, differing chiefly in the relatively smaller dorso-ventral and lateral measurements.

M'Coy relied on "the lengthened form, straight insinuate ventral margin, the side without any oblique concavity, ... as well as the greatest width [dorso-ventral] being a little behind the beak, instead of from the apices," as characteristics of this species; yet, while many shells agree with this description, one or other of these characters often varies.

I think, with M'Coy, that the forms described and figured by Brown (*op. cit. supra*) as *Pachyodon*, and *Unio exoletus*, *antiquus*, *transversus*, and *Lewidensis*, are forms of this species; and to these I would add the forms *Pachyodon* and *Unio agrestis;* but it is impossible to judge accurately from drawings only, and the original specimens have entirely disappeared. Yet, from other localities, I know examples of these forms which I consider to belong to this species.

I am disposed to regard, from inspection of the figures and Goldfuss's description, *Unio tellinarius* as an example of this species. De Koninck appears to have copied Goldfuss's figure, but it is difficult to be certain as to identification, as the original specimens have disappeared.

M'Coy thought that his *Carbonicola subconstricta* was synonymous with the *Unio* and *Pachyodon tellinarius* of the above authors.

Fleming has curiously enough ('History of British Animals,' p. 417, 1828) referred *Unio acutus*, Sowerby, to the Middle Oolite; but this must be an error, for Sowerby gives "Bradford," Yorkshire, as the locality of this shell.

I have been permitted by the kindness of Dr. H. Woodward to figure the

originals of Sowerby's types, which are in the "Sowerby Collection" in the British Museum (Nat. Hist. branch). Fig. 1, Pl. III, is to be regarded as the most typical; but I question whether figs. 2 and 3, Pl. III, do not really belong to *C. subconstricta*, being rather elongated forms of that species; because the umbones in these two specimens do not rise gradually from the shell, as in Pl. III, fig. 1 (and this I have regarded as one of the specific features in *C. acuta*), but are sharply marked off from the surface, as in the specimen of *C. subconstricta*, Pl. VII, figs. 5—15. Indeed, on comparing Sowerby's second specimen of his *Unio acutus* (Pl. III, fig. 2) with his specimens of *U. subconstrictus* (Pl. VII, figs. 5 and 6), little if any distinction can be made between them. M'Coy ('British Palæoz. Fossils,' p. 515) considered that the *Unio aquilinus* of Sowerby ('Geol. Coalbrookdale,' pl. xxxix, fig. 12) was identical with *C. acuta;* but he was in error in this idea, not recognising the characteristically different shape and proportions of the anterior end and the general obliquity of the shell of *C. aquilina;* indeed, there should be no difficulty at all in distinguishing between these two forms.

Few workers in this field have considered it possible that young and immature forms might be met with, and been able to resist the temptation of inventing fresh specific names for such; and amongst these, Brown, Ludwig, and Achepol are conspicuously to the front. I think, from a personal observation of the original specimens, there can be no doubt that Ludwig's *Unio Lottneri* is an elongate variety of the species under description.

Salter's figures in his 'Iron Ores, South Wales, &c.,' pt. 3, pl. ii, figs. 20, 21, do not possess the straight margin of the posterior part of the ventral border. In these two figures the anterior and posterior ends approached more closely to Martin's *Mya ovalis* and Sowerby's *Unio centralis;* but the shells are much elongated transversely. *Unio Lottneri*, Ludwig, is probably identical with Salter's figures.

The great variation in the form of the hinge is very difficult to understand. The hinge-plates figured on Pls. V and VI, with the exception of Pl. V, figs. 1, 2, 32, and Pl. VI, figs. 43 and 44, are all from the same bed—a band of ironstone above the Cockshead Coal, and were obtained by myself from an old pit-mound at the Hulme Colliery, where they had weathered out of the matrix in a fragmentary condition; the hinge itself, owing to its thickness, generally being preserved. I have been able to obtain a very large number of examples, very few of which are exactly alike. Besides the three forms I have ventured to describe, and those showing intermediate features, there are others, of which figs. 4, 5, 6, 12, and 13, Pl. VI, may be taken as examples, showing a total departure from the other forms, and the absence of anything like a cardinal tooth. Pl. VI, fig. 6, shows the anterior two-thirds of the hinge of the right valve; and all the articulating arrangement present is a bevelling of the lower edge of the hinge-plate. In other cases the hinge-plate has been much hollowed out, Pl. VI, figs. 13—16.

A large number of genera might have been founded on the hinge-plates figured, had the specimens been found in different beds; and thus it becomes very apparent that a classification of the *Unio*-like forms of the Coal-measures, founded on slight differences in the hinge, is not justifiable.

Indeed, we find in this one species the edentulous forms which Prof. Amalizky would designate as *Naiadites*, and those with cardinal teeth only, which he would call *Anthracosia;* and a couple of rare forms (Pl. V, fig. 38, and Pl. VI, fig. 2) which have a trace of a posterior lateral tooth—the only specimens indicating such a condition which I have seen, and which would be referred by him to *Carbonicola*.

I believe that no other genus of shells, fossil or recent, exhibits such a curious inconstancy in a character which is generally so regular as to be used as a mark of generic import, and it is difficult to see what conditions could have induced this variation. Living gregariously, with precisely the same environment, and probably interbreeding very closely, it might be natural to suppose that a constant type would have resulted, rather than the amount of variation which really obtains. I cannot make out that any one form of hinge is peculiar to any particular form of *Carbonicola acuta;* nor is there much evidence to show that an equal amount of variation is to be found in other districts, except that Mr. John Ward, F.G.S., has a fine series of interiors of *C. acuta* from the ten-foot seam of North Staffordshire, in which a similar amount of variation is to be seen.

3*. Carbonicola acuta, var. rhomboidalis, nov. Plate III, figs. 13—21; Plate IV, figs. 1—7.

General Characters.—As in *C. acuta*, but the shape is more quadrilateral and less produced transversely. The dorso-ventral measurements are comparatively greater, and the umbones more anterior; while the posterior end, instead of becoming compressed and narrowed, retains its tumidity till close to the posterior border. The posterior slope is slight and inflated; the posterior end very bluntly truncate. The lines of growth posteriorly become bent upwards at a right angle, and are crowded together.

There is often a marked constriction of the surface of the valve, becoming very wide at the inferior border; and this may give rise to the appearance of an obsolete blunted ridge posterior to it, and to the production of the posterior inferior angle of the shell downwards, so that it becomes beaked. In some specimens the lines of growth become oblique to the long axis of the shell (Pl. III, figs. 13, 19).

Dimensions:

Dorso-ventrally	26 mm.
Antero-posteriorly	41 mm.
Laterally	18 mm.

Localities.—Cockshead Coal-roof, Adderley Green.

Observations.—Although this form is very distinct from the types of *C. acuta*, it is nevertheless connected with it by a well-marked series of intermediate forms, and it is impossible to divide them into distinct species. I have therefore considered the extreme form as a variety of *C. acuta*, and have figured a series showing the passage of one into the other. All the specimens came from the roof of the Cockshead Coal of Adderley Green. I have chosen a series of adult specimens of about the same stage of growth in order to make it more easy to follow the transition of shape.

The feature on which Sowerby and M'Coy relied so much for the diagnosis of *C. subconstricta* is well marked in this variety,—more so, indeed, than in the specific type itself. It is probable that the variability in shape has some connection with the variableness of the hinge-character in *C. acuta;* and it will be noted, too, from the figures, that the variety as well as the type-species was subject to erosion of the umbones. A similar variation between an acute and a more quadrate form obtains in *C. aquilina*.

4. Carbonicola ovalis (*Martin*). Plate IV, figs. 18—22; Plate V, fig. 38.

Mya ovalis, *Martin*. Petrefact. Derb., 1809, pl. xxvii, figs. 1, 2; pl. xxviii, fig. 5.
Non Unio uniformis, *Sow.* Min. Conch., 1812, p. 84, pl. xxxiii, fig. 4.
Syn. — acutus, *Dumont*. Geol. of Liége, 1832, p. 356.
— — *Davreux*. Essai sur la constitution géognostique de Liége, 1833, pl. v, figs. 4, 8.
— carbonarius, *Goldfuss*. Petrefact. Germ., 1834–40, p. 181, pl. cxxxi, fig. 19.
— tellinarius, *Goldfuss*. Ibid., p. 180, pl. cxxxi, fig. 16.
— centralis, *Sow.* Trans. Geol. Soc., 1840, ser. 2, vol. v, p. 491, pl. xxxix, fig. 13.
— (no specific name), *Rhind*. Age of the Earth, 1838, pl. ii, fig. f.
Cardinia ovalis, *de Koninck*. Carb. Foss. Belg., 1842–4, p. 74, pl. h, fig. 2.
— atrata, *de Koninck*. Ibid., p. 75, pl. h, fig. 3.
Pachyodon Rhindii, *Brown*. Ann. Mag. Nat. Hist., vol. xii, 1843, pl. xvi, fig. 2.
Unio Rhindii, *Brown*. Foss. Conch., 1849, p. 187, pl. lxxiii, fig. 5.
Non Anthracosia ovalis, *Salter*. Geol. Surv. Mem., Iron Ores S. Wales, pt. 3, 1861, p. 228, pl. ii, fig. 22.
— centralis, *Hull*. Coal-fields Gt. Britain, 1881, p. 38, pl. ii, fig. 4.
Non — — *Ward*. Trans. North-Staff Inst. Min. and Mech. Engineers, vol. x, 1890, pl. i, fig. 16.
Non — subnucleus, *Amalizky*. Palæontographica, vol. xxxix, 1892, p. 156, pl. xx, figs. 19, 20 (said to resemble *Anthracosia ovalis, centralis*, and *uniformis*).

Specific Characters.—Transversely oval with rounded ends; the umbones are more central than in *C. acuta*, and the inferior border is regularly curved, having a convex outline. This curve passes gradually into the anterior and posterior borders, so that the anterior and posterior ends are both regularly rounded. Interior—as in *Carbonicola acuta*. Exterior—striæ and lines of growth concentric.

Dimensions, Sowerby's type of *Unio centralis :*

Antero-posteriorly	35·5 mm.
Dorso-ventrally	23·5 mm.
Laterally	15 mm.

Observations.—This somewhat infrequent form I regard as closely allied to *C. acuta*. Indeed, had it not been for the fact that Martin figured and described the shell, I should probably have considered the form as *C. acuta*. It occurs occasionally in the *C.-acuta*-bed of North Staffordshire (Cockshead roof).

Sowerby, in his 'Mineral Conchology,' substituted the name *Unio uniformis* for Martin's *A. ovalis*, for reasons of nomenclature; but the shell which he described is said to have come from Felmersham, in Bedfordshire, and is therefore an Oolitic species, and not in any way related to Martin's form, which was from the ironstone of Tupton Moor and Staveley. Martin's original specimen has disappeared, but it had the characteristically curved lower border rounded off anteriorly and posteriorly. Martin describes "one end pointed," but the figure shows for the posterior end a different shape from the ordinary form of *C. acuta*.

I regard Sowerby's form of *Unio centralis*, from Coalbrookdale, pl. xxxix, fig. 13, in Prof. Prestwich's memoir, as identical with Martin's species, and I have been permitted, by the kindness of Prof. Prestwich, to re-figure the original specimen, Pl. IV, fig. 18. This specimen shows umbones more central than usual, but this is due to some imperfection of the posterior end. Pl. IV, fig. 19, is a cast of another specimen from the same locality, and is in the Nottingham Museum. One other specimen from the same collection is in Pl. IV, fig. 22, from Butterley, Leicestershire. Pl. IV, figs. 20 and 21, are forms lent me by Mr. J. Neilson from the Kenmuir and Clydesdale pits near Glasgow, the latter of which shows a form intermediate between *C. acuta* and *C. ovalis*.

Salter's figure of *Anthracosia ovalis* in the 'Geological Survey Memoir on the Iron Ores of Great Britain,' part 3, pl. ii, fig. 22, is, I think, that of a totally different shell, viz. *Carbonicola turgida*. The hinge-characters are shown on Pl. V, fig. 38, in a specimen which I obtained from the Cockshead rock, which lies some little way above the Cockshead Bass (the *C.-acuta*-bed).

It has the form γ, which I have described above under *C. acuta:* thus in the right valve a central subumbonal tooth, with concavity anterior and posterior to

it; in the left valve a split cardinal tooth, which receives between its two halves the tooth of the opposite valve; anterior and posterior laterals are absent. In the figure will be noticed a faint oblique line on the posterior part of the hinge-plate, which, with a similar occurrence in Pl. VI, fig. 2, are the only indications of horizontal lateral teeth that I have met with. Pl. V, fig. 38, contains a small pearly nodule, well shown at "a" in the drawing.

That this form of hinge-plate (γ) is not confined to *C. ovalis* is certain, I think, from the occurrence of a similar form in specimens having the typical shape of *C. acuta*.

Prof. Amalizky[1] has referred a new species of his, named *Anthracosia subnucleus*, from the Permian formation of the Oka Volga Basin, as allied to the forms—*U. ovalis*, Martin; *U. centralis*, Sow.; *U. uniformis*, Sow.; *U. nucleus*, Brown; and *U. ovalis*, Salter. Judging, however, from the figures, dimensions, and description, his shell is totally different from the form under discussion, and I have shown above that the forms referred to are themselves very different, one of them being from the Oolite.

Localities.—England: Tupton Moor and Staveley. Roof of the Cockshead Seam and the Cockshead Rock, Lower Coal-measures of North Staffordshire. Pennystone Beds, White Flats, Blue Flats—Coalbrookdale. Butterley, Leicestershire. Old Coal, South Wales. Scotland: Kenmuir and Clyde Pits, Lanarkshire Coal-field.

5. Carbonicola Polmontensis (*Brown*). Pl. VII, figs. 1—4.

Unio (from Coal-shale), ***Rhind.*** Age of the Earth, pl. ii, figs. c, d.
— Polmontensis, ***Brown.*** Foss. Conch., pl. lxxiii, figs. 32, 33.

Specific Characters.—Transversely elongate-oval; sides flatly convex. Umbones are much elongated transversely, narrowed, apart, and everted anteriorly, situated at two-fifths of the length of the shell from the anterior end, which is rounded. The posterior end is compressed and bluntly pointed. The hinge-line is straight, and in casts median. The interior of the shell shows fine striæ radiating from the umbones to the surface. Posterior slope obtusely rounded; upper surface expanded. There is an oblique, shallow, broad depression on the sides of the shell, most marked towards the posterior part of the inferior border. External characters unknown. Muscular scars normal. Pallial line not very far from the margin of the shell.

[1] 'Palæontographica,' vol. xxxix, 1892; 'Ueber der Anthracosien die Perm-formation Russlands,' 156, pl. xx, figs. 19, 20.

Dimensions:

Antero-posteriorly	48 mm.
Dorso-ventrally	27 mm.
Laterally	15 mm.

Locality.—Coal-shale, Polmont, near Falkirk. Springhill Colliery, near Kilmarnock. Kirkwood Upper Coal-measures, Ell-coal, Kilwinning, Ayrshire.

Observations.—I have met with this form only in Scotch localities. Unfortunately I have not seen any testiferous examples, and am quite unable to state anything as to the external characters of the shell. The form was originally figured by Dr. Rhind in his little work 'The Age of the Earth,' and was named *Polmontensis* by Captain Brown from the locality whence it was first obtained, and he refigured the shell, giving a typical figure of the umbones and upper surface of the shell as shown in a cast. In casts the peculiar long, narrow, widely-separated umbones are quite characteristic.

I figure specimens from the several Scotch localities, which are all in the Upper Coal-measures. The figures show a slight variation in shape.

The shell appears to have some resemblance to *C. acuta*, but it is flatter, and differs from that species in the peculiarity of the umbones.

6. Carbonicola subconstricta (*Sowerby*). Plate VI, fig. 44; Plate VII, figs. 5—15.

Unio subconstrictus, *Sow.* Min. Conch., vol. i, 1812, p. 83, pl. xxxiii, figs. 1—3.
— — *Defrance.* Dict. Sci. Nat., 1824, vol. xxxiii, p. 294.
— — *Dumont.* Constitution géologique Liége, 1832, p. 356.
— — *Goldfuss.* Petrefact. Germaniæ, 1834–40, pl. cxxxi, fig. 18.
Cardinia subconstricta, *Agassiz.* Trad. de Sowerby's Min. Conch. (1842), p. 58, pl. xxiii, figs. 1—3.
— — *de Koninck.* Carb. Foss. de Belgique, 1842–4, p. 73, pl. I, fig. 9.
Pachyodon subtriangularis, *Brown.* Ann. and Mag. Nat. Hist., 1843, vol. xii, p. 393, pl. xvi, fig. 6.
— Smithii, *Brown.* Ibid., p. 393, pl. xvi, figs. 7, 8.
— Embletoni, *Brown.* Ibid., p. 393, pl. xvi, fig. 9.
— Heyii, *Brown.* Ibid., p. 393, pl. xvi, fig. 10.
Unio subtriangularis, *Brown.* Fossil Conch., 1849, p. 178, pl. lxxiii, fig. 12.
— Smithii, *Brown.* Ibid., p. 178, pl. lxxiii, figs. 10, 11.
— Embletoni, *Brown.* Ibid., p. 178, pl. lxxiii, fig. 6.
— Heyii, *Brown.* Ibid., p. 178, pl. lxxiii, fig. 1.
Carbonicola subconstricta, *M'Coy.* Brit. Palæozoic Foss., 1855, p. 515.
Anthracosia Smithii, *King.* Ann. Mag. Nat. Hist., ser. 2, vol. xvii, 1856, pl. iv, fig. 6.

Specific Description.—Shell ovate; anterior end rounded and short. Posterior end obliquely truncate from above downwards and bluntly rounded. Somewhat

narrowed by a convergence of the dorsal and ventral margins. Inferior border uniformly and convexly curved, or there may be a concave sinuation in it posteriorly.

Umbones situated in the anterior one-third of the shell raised above the rest of the shell, tumid and very blunt, widely separated in casts and excavated internally in front, so that they appear to have an oblique direction forwards and outwards. Lunule wide, rapidly widening anteriorly, marked by longitudinal striæ, which are continuous with lines of growth of the shell. In those specimens which have a sinuated ventral margin an almost obsolete, shallow, broad, oblique constriction is seen on the side of the shell, commencing near the umbones, it passes downwards and backwards, gradually widening until it terminates in the sinuated portion of the inferior border.

Valves somewhat convexly flattened; greatest convexity is situated immediately below the umbones. Posterior slope bluntly rounded or angulated. Hinge-line straight in casts, and there is no indication of any anterior or lateral cardinal teeth. In right valve there is a single obliquely diverging tooth, with a pit posterior to it to receive the corresponding tooth of left valve.

Shell moderately thick, marked with concentric striæ and very fine lines of growth.

Plate VII, fig. 8, measures—

Antero-posteriorly	38 mm.
Dorso-ventrally	22 mm.
Laterally	15 mm.

Localities.—Low Moor, Bradford; Thin bed, Burnley.

Observations.—I have been permitted to refigure the original shells of Sowerby's figures of *Unio subconstricta* (Pl. VII, figs. 5—7) by the kindness of Dr. H. Woodward. The feature of the shallow oblique sinus is not at all uncommon in many other species of *Carbonicola*, and can no longer be regarded as a specific character. As a matter of fact, it is much shallower in the form under description than obtains in many specimens of *C. acuta* and *C. robusta*; indeed, M'Coy (*op. cit.*, p. 515) thought that *C. robusta* was only an adult form of *C. subconstricta*.

I know of only two specimens which retain the shell, and these are in the "Sowerby Collection" (British Museum). There is also a fine series of casts in the Woodwardian Museum at Cambridge, which nevertheless show very faint striæ over the lower part of the shell (figs. 8—10, Pl. VII).

The form of *C. subconstricta* appears to me to connect *C. acuta* with *C. aquilina*, there being a marked approach towards the shape of the anterior end of *C. subconstricta* and *C. aquilina*; and there is also to be noted in the former a slight degree of obliquity to the long axis of the shell in the lines of growth.

M'Coy laid great stress upon the presence of an obtuse angle along the dorsal

margin, and suggested that the *Unio tellinarius* of Goldfuss and de Koninck, which is also stated to possess this character, may belong to Sowerby's species.

The only specimen showing the hinge-character of this species is in the Woodwardian, and I have been allowed to figure it and other specimens from that collection by the kindness of Professor McKenny Hughes (Pl. VI, fig. 44). In the drawing the fragment is looked at from below, and shows the lower edge of the hinge-plate, which is non-articular, the upper part of the plate being in consequence foreshortened.

This fragment shows a total absence of any prominence which can be constructed into an anterior lateral tooth; but there is a sloping surface continuous above the striated lunule, which becomes thickened and raised, immediately below the umbo, into an oblique posteriorly diverging cardinal tooth. Immediately posterior to it is a pit, so that the tooth in the right valve is immediately in front of that in the left valve; the pit in the right valve has a plain triangular surface, and there is no evidence of any posterior lateral tooth.

M'Coy states (p. 515, *op. supra cit.*), "Casts show the thick cardinal tooth, and slender, elongate, lamellar lateral teeth." I am unable to understand this statement, as I cannot conceive it possible for the cast of a bivalve shell, the valves being in their natural position, to show anything of the sort. The Professor evidently mistook the groove left in casts on each side of the middle line by the lower edge of the hinge-plate, both anteriorly and posteriorly, to represent anterior and posterior lateral teeth. I have made a series of plaster casts of *Unio tumidus*, which have definite lateral lamellar teeth, but can obtain no indication of them in the casts.

This shell does not appear to have a very wide distribution. I only know of the above-mentioned localities where it occurs; and it appears to be confined to the horizon of the Low Moor Ironstone beds.

The large specimens, figured Pl. VII, figs. 11 and 15, belonging to Mr. George Wild, of Bardsley, are from the Fullege Colliery, Burnley, and at about the horizon of the Thin bed.

7. Carbonicola obtusa, sp. nov. Plate VII, figs. 16—23; Plate XI, figs. 1, 2.

Specific Characters.—Shape variable, but more or less subquadrate and flattened. The anterior end is moderately convex, short but deep in a dorso-ventral direction; its border circularly rounded. The inferior border is rounded in front, becoming almost straight posteriorly. The posterior part of the shell is narrowed from above downwards by the slope of the upper border, which leaves a long, bluntly rounded or truncate posterior border.

The umbones appear to rise gradually from the whole surface of the shell, and are blunt, raised above the hinge-line; excavated anteriorly, and thinned internally by the encroachment of the lunule, which is moderately deep, widens anteriorly, and is roughly marked by striæ continuous with the lines of growth which pass into it from the surface of the shell. The external ligament is prominent and erect, extending half the way from the umbones to the posterior end. The hinge-line is slightly arched. Hinge-plate triangular as in *C. acuta*, the normal form; but, owing to the more quadrate and stumpy form of the shell, this part of the plate, posterior to the cardinal tooth, is placed at an obtuse angle to the anterior portion.

Valves compressed with an almost obsolete, broad, oblique sinus, most apparent at the lower border. The posterior slope is dilated and obtuse. Shell thick. Muscle-scars normal.

The surface is rough with coarse lines of growth. Periostracum thick and much wrinkled.

Dimensions (Pl. VII, fig. 18):

Antero-posteriorly	35 mm.
Dorso-ventrally	25 mm.
Laterally	16 mm.

Localities.—The roof of the Ten-foot Coal, and the horizon of the Cockshead Rock, Hulme Colliery. Ivy House Colliery, Bucknall. Whitfield Colliery. All in the Lower Coal-measures of North Staffordshire; Middle Coal-measures of Oldham.

Observations.—The form of this species appears to be less variable than most; and although fig. 22, Pl. VII, appears to differ in form from the others, it will be noted that the shell is imperfect at the posterior-inferior angle.

Since having the plates printed I have lifted fig. 16, Pl. VII, from the matrix, and cleaned out the hinge-plates, finding them to be exactly on the plan of that shown in Pl. V, fig. 1. I have not been able to get at more than two interiors, but these do not vary at all. On Pl. XI, fig. 1, is the figure of the hinge-plate of fig. 16, which will be of interest, as it is very rarely that the hinge-plates of two opposing valves can be studied.

The lines of growth are more rough, irregular, and deeper cut than in other forms; and this point, taken in connection with the shape, will serve as diagnostic in determining the species.

This species occurs at only one horizon in the North-Staffordshire Coal-field, but in great abundance, whole beds being made up of it. It is rare in certain places to find the valves in contact, showing that the shells were probably washed into little bays after death. In these places are to be found occasionally a pair of valves opened out as in Pl. VII, fig. 16.

8. Carbonicola nucularis, sp. nov. Plate VII, figs. 24—42; Plate IX, fig. 11; Plate XI, figs. 14 and 16.

Specific Characters.—Shell produced transversely in adults, moderately gibbous, evenly convex, more so comparatively in young forms. Anterior end short, about one-fourth of the whole shell, with a regularly curved border meeting the hinge-line above at an angle, but passing into the inferior border with a regular curve. Inferior border broadly curved in its anterior half; then becoming straight and slightly sinuous. Posterior border bluntly rounded; in older forms the junction with the inferior border is somewhat angular. Hinge-line apparently slightly arched, due to the meeting of the anterior and posterior parts at an obtuse angle. The posterior end is regularly and evenly compressed into its lower and posterior borders; but above the posterior-dorsal slope is expanded, subcarinate, and slightly concave above. Umbones obtuse and blunt, remote, varying slightly in position, never central, somewhat raised above the hinge-line; lunule small. Hinge-plate narrow; the anterior and posterior parts meet at a very wide angle. In the right valve there is a small cardinal tooth just posterior to the umbo, with a pit behind it, Pl. IX, fig. 11. The posterior part of the plate is a narrow ledge, with a groove above it for the ligament. Interior normal. Internal surface very smooth, marked on the posterior slope by radiating lines.

Surface in the two testiferous forms marked with very faint concentric lines of growth. Periostracum much wrinkled.

Measurements:

	Antero-posteriorly.	Dorso-ventrally.	Laterally.
	28 mm.	17 mm.	11·5 mm.
Medium forms	20 „	14 „	10 „
Young forms	16 „	12 „	9·5 „

Localities.—England: Hard-mine roof, North Staffordshire. Mountain Mine, Wigan. Doe Hill, Nottingham. Leicester Coal-field. Coal-measures, South Wales. Scotland: Limestone-Shale, Dunfermline.

Remarks.—There is some resemblance between the species under description and the figure given by Mr. R. Etheridge, jun., in the 'Quart. Journ. Geol. Soc.,' vol. xxxiv, pl. ii, fig. 20, under the name of *Anthracosia? nucleus* (Brown?), but he states that the specimen was too imperfect to give a description of it. It was from the original locality of Captain Brown's *Unio* and *Pachyodon nucleus*, the description of which differs only from my form in the fact that it is said to possess a posterior end elongated and acute, whereas I have never found a specimen which can be considered to be acute. Mr. Etheridge, jun., considered it probable that Brown's shell was identical with one form of Rhind's *Anodonta Pentlandica*, 'Age

of the Earth,' pl. ii, fig. A. I have unfortunately not been able to see any specimens from the given Scotch localities, and therefore cannot state anything about the probable nature of the shell, and I have thought it best to invent a new term for the species under notice. I have had the pleasure of examining two specimens, which I here name *C. uncularis*, from Dunfermline, in the Braidwood Collection of Dr. Hunter, although they are somewhat different from my other examples. As far as I know, the species has a limited horizontal and vertical range, and I can only quote three localities. In the Hard-mine roof in North Staffordshire, whence I have obtained about fifty specimens, it occurs with *C. aquilina*, *Anthracomya Williamsoni*, and three forms of *Naiadites*, and in about the same proportion as *A. Williamsoni*, both being markedly less frequent than the associated shells.

I have figured a series from this bed in order to show the amount of variation which occurs. All my specimens have been gathered in about one square mile, with the exception of figs. 30 and 31, Pl. VII.

The blunt posterior end seems characteristic. This form is not met with of greater size than fig. 25, Pl. VII; and specimens as large as this are by no means common. If the hinge-line be carefully examined in many, there will be noted a slight S-shaped curve between the umbones, indicating cardinal teeth, the curve showing the right cardinal tooth to have been anterior. This sinuation is so very slight that in some shells it may be easily overlooked. I have never found any testiferous specimens in the south-east end of the coal-field. The two figs. 30 and 31 come from beds of the same horizon at Talk-o'-th'-Hill. I was fortunate enough, among the specimens from the Mountain Mine of Wigan, sent me by Mr. Waring, to find one in which the valves had slipped, so that the anterior part of the hinge-plate was seen. I did not think it necessary to figure it, as I had before figured specimens showing the normal plan of the hinge apparatus, Pl. V, fig. 1, as it occurs in *C. acuta*.

The specimens from Wigan and Leicestershire show very fine lines of growth indeed, and the same condition is very apparent (in the testiferous specimens figured) beneath the much-wrinkled periostracum.

In the Cardiff Museum I have noted a series of four which retain the shell and periostracum. They are truncate forms, like those figured in Pl. VII, figs. 36, 40, and 41. Unfortunately the horizon at which they occurred in the South Wales Coal-field is not stated.

The shell is more tumid and regularly swollen for its size than any other form, and the umbones are lower and less pronounced.

9. Carbonicola gibbosa, sp. nov. Plate VIII, figs. 1, 1 *a*, 1 *b*, 2.

Specific Characters.—Shell massive, very gibbous, somewhat oblique. Anterior end short, swollen, and deeply excavated above by the lunule, so that it is almost bluntly pointed. The posterior end comprises most of the shell, and is very tumid, becoming gradually compressed toward the posterior end into the border. This end is curved obtusely and rapidly downwards from the end of the hinge-line to meet the inferior border at a blunted angle, which would be a right angle were it not rounded. Inferior border very slightly convex for the greater part of its length, becoming slightly concave posteriorly.

The hinge-line, if produced anteriorly, would form a very acute angle with the inferior border, and is somewhat arched and comparatively long. The external ligament extends nearly to the posterior end of the hinge-line. The umbones are very gibbous and obtuse; with the beaks curved forwards and downwards, contiguous, raised above the hinge-line, and excavated anteriorly by a deep and broad lunule, which is heart-shaped. Surface covered by concentric lines of growth and striæ, which are oblique to the long axis of the shell. Interior not seen.

Dimensions:

Antero-posteriorly	45 mm.
Dorso-ventrally	32 mm.
Laterally	31 mm.

Locality.—Shale above the roof of the Moss Coal, Longton.

Observations.—The only other form of *Carbonicola* which approaches the one under description is *A. turgida*, of which it is quite possible that it may be a very large variety. The lunule of the species under description is comparatively wider and deeper. I only know of two specimens of the shell. From the cabinet of Mr. J. Ward, of Longton, who obtained them from the roof of the Moss Coal, North Staffordshire Coal-field. This shell must be very rare indeed.

Fig. 1, Pl. VIII, is a very perfect specimen, and I have given three views of it.

Fig. 2, Pl. VIII, is a less perfect form, and has been somewhat crushed.

10. Carbonicola subrotunda (*Brown*). Plate VIII, figs. 3—7.

Pachyodon subrotundus, *Brown*. Ann. Mag. Nat. Hist., 1843, vol. xii, pl. xv, fig. 8.

Unio subrotundus, *Brown*. Fossil Conchology, 1849, pl. lxxiii, fig. 22.

Pachyodon Dawsoni, *Brown*. Ann. Mag. Nat. Hist., 1843, vol. xii, pl. xv, fig. 10.

Unio Dawsoni, *Brown*. Foss. Conch., 1849, pl. lxxiii, fig. 3.

? — — *Garner*. Nat. Hist. Staffordshire, 1844, pl. E, fig. 20.

Specific Characters.—Shell subrotund, tumid ; the anterior part almost equal to the posterior in size. Anterior, inferior, and posterior borders rounded; its posterior inferior angle less regularly curved than the rest of the margin. Umbones central or slightly subcentral, tumid, obtuse, separated and raised above the hinge-line, which is slightly arched, with the convexity upwards. Lunule distinct and elongated. Ligament external, nearly as long as the posterior part of the hinge-line. Surface with concentric striæ and lines of growth. Periostracum thick and much wrinkled. Interior unknown.

Dimensions :

Antero-posteriorly	31 mm.
Dorso-ventrally	23 mm.
Laterally	21 mm.

Localities.—Banbury Seam, Adderley Green, Longton, North Staffordshire. Oldham; Lowmoor, Bradford; Wednesbury Oak.

Observations.—The figures of *Unio* and *Pachyodon Dawsoni* (Brown) are very characteristic of entire specimens of this shell; those of *U.* or *P. subrotundus* are typical of crushed forms, giving rise to the appearance of alæ on each side, and forcing the umbo to one side or other.

The form is very characteristic, and seems to vary less than any other species of this genus. I consider it to be a rare form; and, although Captain Brown quotes the occurrence of this species from Lowmoor and Oldham, I have not met with any specimens except in North Staffordshire, neither have I come across examples in any museum.

The figured specimens all show much wrinkling of the periostracum, which was probably, therefore, very thick. I have several other specimens from the same locality, but they are much crushed, and when in this condition resemble Brown's figure of *Unio Dawsoni*. I have adhered to the name "*subrotunda*," as the figure by which *U. subrotundus* is represented is one of a much more perfect specimen than that of *U. Dawsoni*.

11. Carbonicola turgida (*Brown*). Plate VIII, figs. 8—25.

Pachyodon turgidus, *Brown*. Annals Mag. Nat. Hist., vol. xii, 1843, p. 394, pl. xvi, figs. 13, 14.
— dubius, *Brown*. Ibid., p. 392, pl. xvi, fig. 5.
— similis, *Brown*. Ibid., p. 393, pl. xvi, fig. 12.
— Blaydsii, *Brown*. Ibid., p. 394, pl. xvi*, fig. 2.
Unio turgidus, *Brown*. Fossil Conchology, 1849, p. 178, pl. lxxiii, figs. 10, 17.
— dubius, *Brown*. Ibid., p. 177, pl. lxxiii, fig. 13.
— similis, *Brown*. Ibid., p. 178, pl. lxxiii, fig. 9.
— Blaydsii, *Brown*. Ibid., p. 178, pl. lxxiii, fig. 2.

CARBONICOLA TURGIDA, *M'Coy*. British Palæoz. Foss., 1854, p. 516.
ANTHRACOSIA OVALIS, *Salter*. Memoirs Geol. Surv. Great Britain, Iron Ores, &c., 1861, pt. 3, p. 226, pl. ii, figs. 22, 22 *a*.
— CENTRALIS, *Ward*. Transact. North Staffordsh. Instit. Min. Mech. Engineers, vol. x, 1890, p. 126, pl. i, fig. 16.

Specific Characters.—Shell obliquely and obtusely oblong, very gibbous. The anterior end, situated below the level of the umbones, has a rounded anterior superior angle and an obtusely rounded border, passing by a gradual curve into the inferior border. The anterior part of the shell is small and compressed at the border, but swelling rapidly. The posterior end forms the greater part (about two-thirds) of the shell, and it becomes compressed above into the hinge-line and border. The posterior border is obliquely truncate with an obtuse angle. Ventral margin nearly straight. Hinge-line straight, about half the total length of the shell, oblique to the long axis of shell. Umbones situated about the centre of the hinge-line, large, obtuse, contiguous. Lunule elongate and narrow. Ligament external and short. The edges of the valves posterior to the ligament are bevelled at the expense of the upper border, forming an elongated V-shaped trench. Valves very tumid, more so anteriorly, becoming gradually flattened posteriorly, marked with fine concentric striæ and lines of growth, often slightly oblique to the long axis of the shell, also very fine radiating striæ. Interior very smooth. Muscle-scars: anterior-adductor scar circular and shallow, almost marginal; accessory pedal-scar above it. The posterior-adductor scar is ovately triangular, situated high up near the posterior superior angle of the shell. In the right valve the lower edge of the anterior portion of the hinge-plate is bevelled and facetted at the expense of its lower border, and above this is a slight horizontal ridge, which is the inner edge of the lunule. The lunule terminates in a ridge directed obliquely backwards and downwards, which is the cardinal tooth, and behind it is a pit for the reception of the cardinal tooth of the left valve. Posterior to this pit the hinge-plate is thickened into a boss, forming a second cardinal tooth. The rest of the hinge-plate is flat and smooth.

Dimensions:		Scotch specimen.
Antero-posteriorly . .	37 mm.	43 mm.
Dorso-ventrally . .	23 mm.	30 mm.
Laterally . . .	18 mm.	20 mm.

Localities.—England: Stubbs' Mine, Bardsley, Coalbrookdale. Grain's Ironstone, Farthing Lane, Dudley. Roof of the Moss Seam, North Staffordshire. Stanley Main and Shale Coal, Wakefield. Wales: Two feet above bottom vein, Gantre, Ebbw Vale, South Wales. Scotland: Dallmellington, Lurgar. Splint Coal, Wishaw Coal-measures. Upper Coal-measures, Cambuslang and Shettleston.

Observations.—Captain Brown, who first described this form, gave two very

good figures (*op. supra cit.*), but in this same paper described, under the names of *Pachyodon dubius* and *P. similis*, two shells which I consider to belong to the same species. His figure of *P. dubius* resembles the specimen I have figured on Pl. VIII, fig. 17, from the collection of Dr. John Young, and which I regard as a young example of this species.

The description given by M'Coy is very accurate and striking. He states that "this species is easily distinguished from all others by its short quadrate form and evenly gibbous, very tumid valves." This form does not appear to have been recognised by Mr. Salter; for he figures a specimen of it (*op. supra cit.*), under the name of *Anthracosia ovalis* (Martin), which shows not the slightest resemblance to Martin's original figure.

Mr. Ward figures a somewhat imperfect specimen from the roof of the Moss Coal (*op. supra cit.*) under the name *Anthracosia centralis*, but it has the tumid prominent umbones of the species under notice. I have figured a number of crushed and smaller forms from this bed, which may be young of *C. turgida*, Pl. VIII, figs. 21—25. The peculiar shapes in these cases are due to crushing-in of the lower edges of the shell and separation of the valves, but they all possess the characteristically shaped posterior slope and prominent tumid umbones. This species is not at all common, and where it occurs has a very small vertical range; but it seems to have had a wide horizontal distribution. It is one of the most elegant of the Coal-measure shells when perfect; but it is often difficult to recognise when crushed. The form, too, is fairly constant; but it will be observed that the obliquity of the striæ so marked in some specimens (Pl. VIII, figs. 8, 12, and 18) is not always present; figs. 10, 13, 19, and 20 showing an almost perfect concentric arrangement. Whether this variation is due to locality I cannot say, but all the specimens which have come into my hands from Coalbrookdale and most of those from North Staffordshire are not obliquely grown. Most of the Scotch forms appear as casts.

The form is closely allied to *C. gibbosa*, which perhaps may be only a giant variety; but there are certain differences, which have induced me to separate the two forms.

The cast of the hinge-line, fig. 15 *a*, Pl. VIII, indicates by the S-shaped flexure between the umbones the presence of cardinal teeth.

The name *turgida* has been adopted because the shells figured by Captain Brown under this term are more typical than those figured under those names which I have regarded as synonymous.

12. Carbonicola aquilina, *Sowerby*. Plate V, fig .2; Plate IX, figs. 1—10, 12—37; Plate X, figs. 1—42; Plate XI, figs. 31—33.

Unio (no specific name), *Ure*. Natural History of Rutherglen, 1793, pp. 310, 311, pl. xvi, fig. 4.
— aquilinus, *Sowerby*. In Prestwich, J., On the Geology of the Coal-field of Coalbrookdale (read April 27th, 1836), Trans. Geol. Soc. London, ser. 2, vol. v, 1840, pl. xxxix, fig. 12.
— phaseolus, *Sowerby*. Ibid., pl. xxxix, fig. 11.
— atratus, *Goldfuss*. Petrefacta Germaniæ, livr., 1837, p. 180, pl. cxxxi, fig. 16.
Pachyodon lateralis, *Brown*. Ann. and Mag. Nat. Hist., 1843, p. 391, pl. xv, fig. 3.
— sulcatus, *Brown*. Ibid., p. 391, pl. xv, figs. 4 and 5.
— bipennis, *Brown*. Ibid., p. 391, pl. xv, fig. 9.
Unio lateralis, *Brown*. Fossil Conchology, 1849, p. 177, pl. lxxiii, fig. 26.
— bipennis, *Brown*. Ibid., p. 177, pl. lxxiii, fig. 27.
— sulcatus, *Brown*. Ibid., p. 177, pl. lxxiii, figs. 28, 29.
— aquilinus, *Brown*. Ibid., p. 181, pl. lxxviii, fig. 23.
— phaseolus, *Brown*. Ibid., p. 181, pl. lxxviii, figs. 21, 22.
Anthracosia Beaniana, *King*. Ann. and Mag. Nat. Hist., 1856, ser. 2, vol. xvii, p. 54, pl. iv, figs. 1, 2.
Unio securiformis, *Ludwig*. Palæontographica, Band viii, 1859, p. 33, pl. iv, figs. 1—9.
Anodonta procera, *Ludwig*. Ibid., p. 36, pl. v, figs. 9, 10.
— cicatricosa, *Ludwig*. Ibid., p. 35, pl. v, figs. 7, 8.
Unio crassidens, *Ludwig*. Ibid., Bd. viii, 1861, p. 184, pl. lxxi, figs. 15—17.
Anthracosia aquilina, *Salter*. Mem. of the Geol. Survey of Great Britain, Iron Ores of South Wales, pt. 3, 1861, pl. ii, fig. 17.
— æquilinus, *Hull*. Coal-fields of Great Britain, 1873, pl. i, fig. 5.
— securiformis, *Koenen*. Zeitsch. Deutsch. Geol. Gesell., vol. xxxiii, 1881, p. 686, pl. xxvi, figs. 6 and 7.
Non — aquilina, *Ward*. Trans. North-Staff. Inst. Mining and Mech. Engineers, vol. x, 1890, p. 128, pl. i, figs. 5 and 14.
— Beyrichi, *Achepol*. Niederrheinisch.-Westfälliche Steinkohlen Gebirge, Atlas, 1880–83, p. 60, Blatte xvii, figs. 4, 20; Supplement, iii, figs. 17—21.
— Serloi, *Achepol*. Ibid., p. 84, cuts 1 and 2; Supp. iii, figs. 23—29.
— Lottneri, *Achepol*. Ibid., Supp. iv, fig. 4.
— Decheni, *Achepol*. Ibid., Supp. iv, figs. 8—10.
— Hauchecornei, *Achepol*. Ibid., Supp. iv, figs. 13, 15.
— Berendti ?, *Achepol*. Ibid., Supp. iv, figs. 47, 48.
— Römeri, *Achepol*. Ibid., Supp. iv, figs. 79, 80.

Specific Characters.—Shell transversely ovate, flattened and compressed, variable. Anterior end rounded, compressed, and small, its upper border being at

a lower level than the rest of the shell. The inferior border, convex anteriorly, soon becomes almost straight. The posterior part of the shell is produced, uniformly tumid, and is hardly compressed till near the borders. The posterior border may be rounded or obliquely truncate from above downwards, or almost pointed. The upper borders of the valves are flattened and expanded, so that the greatest convexity of the shell is on a level with the hinge, this rendering the posterior slope very blunt and angular.

The umbones are anterior, slightly everted, obtuse, with the apices directed forwards and remote. They rise in front by a well-marked curved fold which has a well-defined edge, and takes its origin from the surface of the valve below the upper edge of the valve, which appears to be compressed anteriorly to and above the fold. Posteriorly the umbones pass into the posterior slope very gradually. The hinge-line is below the level of the upper surface of the valves, and each valve is channelled above by a longitudinal groove which lies between the hinge-edge, which is compressed and raised upwards, and the posterior umbonal slope. These grooves are well marked in casts. The external ligament is inserted into the bottom of these grooves, where the fibres appear to be continuous with the lines of growth, as they turn over the upper border of the shell and dip into the groove.

The surface is marked by fine or coarse lines and striæ of growth, markedly oblique in their arrangement to the long axis of the shell and eccentric. These striæ are crowded and very convexly curved at the anterior end, but they gradually become further apart and almost straight till they are rapidly reflected at an angle over the umbonal slope, when they become directed forwards and inwards. The surface is often subsulcated.

The hinge-plate consists of two portions which are placed at an angle with each other, the direction of the anterior part being upwards and backwards, and that of the posterior part almost horizontal, but there is no plate of shell connecting the two portions. I quote King's original description of the hinge apparatus :— "Teeth, one in each valve below (and anterior to) the umbo, rather low and massive ; crown of tooth of right valve excavated anteriorly (and below) and ridged posteriorly ; crown of tooth of left valve ridged anteriorly and sloped posteriorly." These teeth may be facetted. The posterior part of the hinge-plate joining the anterior part at an acute angle is flattened, or sometimes rounded, and excavated as in Anodon for the posterior terminal attachment of the external ligament, and ultimately is lost on the inner surface of the shell.

Above the hinge-plate is a longitudinal groove formed by the curving round and terminating of the lines of growth, which serves for the lateral attachment of the ligament.

Interior.—The anterior-adductor scar is almost marginal, the front part being

deep and smooth; the hinder gradually becomes more shallow, and is rough and subdivided by numerous irregularly branching lines. The anterior accessory pedal scars are small, pit-like, and situated immediately behind the posterior-superior angle of the anterior adductor.

The posterior-adductor scars are shallow, somewhat broader posteriorly than anteriorly, situated within the posterior slope close to the hinge-line, and not far from the posterior end. The position of both adductor muscles is often indicated on the exterior of the shell by marked depressions due to muscular strain.

Casts indicate a longitudinal groove between the umbones and the hinge-edge, Pl. X, figs. 19 *a*, 20 *a*, 21 *a*, and a broad, deep excavation anterior to the umbones for the hinge-locking teeth, crossing which the line representing the junction of the two valves becomes sinuously curved, being deviated from before backwards, first to the right and then to the left, demonstrating the presence of cardinal teeth in the valves, of which that in the left is slightly anterior to that in the right. There is always posteriorly a raised central ridge corresponding to the interval between the hinge-plates, which shows that the "posterior elongate lamellar teeth" of M'Coy and Amalizky are absent. The surface of casts is marked by broad, shallow, eccentric sulci, and often with obscure radiating lines.

Dimensions:	Antero-posteriorly.	Dorso-ventrally.	Laterally.
Pl. IX, fig. 6 .	45 mm.	18 mm.	14 mm.
Pl. X, fig. 5 .	40 mm.	16 mm.	10 mm.
Pl. IX, fig. 1 .	30 mm.	15 mm.	10 mm.

Observations.—This species is by far the most common form in British coal-measures, both in its vertical and horizontal range, and it also occurs in many localities abroad, in Belgium and Germany, a fact which is well attested by the list of synonyms. The shell is very variable indeed in shape, size, and also in the strength of the surface striæ; but I have not been able to convince myself of the necessity of giving varietal names, from the study of large numbers of shells belonging to this species from the same and different beds. I find that all forms are met with in the beds at Whitley, Northumberland, the Hard Mine, North Staffordshire, and the Grain's, Gubbin, and Brooch Ironstones, South Staffordshire, showing, I think, by the presence of all the extreme forms and complete series of intermediate ones, that they were all fertile *inter se*.

The hinge characters appear to be constant, and to bear out Professor King's observations (*op. supra cit.*), and I have met with no variation except that of degree in the form of the hinge.

It is important to note that abroad Ludwig, Amalizky, and others have mistaken the sharp superior edge of the posterior part of the hinge-plate with the groove

for the insertion of the ligament parallel to it, for the elongate lamellar teeth of M'Coy, which are not indicated in casts, and are characteristically absent in the hinges of *C. aquilina*, which I figure Pl. IX, figs. 5, 9, 12—14. In the many fragments exhibiting all parts of the hinge-plate which have passed through my hands I have never observed any indications of lateral teeth, my experience completely coinciding with Professor King's original observations on this point.

The diagnostic features on which I have relied for the identification of this species are the shape of the anterior end and the umbones, and the obliquity of the lines of growth, taken together with the wedge-shaped, flattened form of the sides of the valves and the broadly channelled upper border, characters which are well shown in Sowerby's original figure in Professor Prestwich's 'Geology of Coalbrookdale.'

It is quite possible that the original of Ure's shell may have belonged to the species under discussion, but the shell itself is lost. The characteristic oblique lines of growth are indicated in his figure, and Dr. John Young, of the Hunterian Museum, Glasgow, showed me a specimen from the original locality which was certainly *C. aquilina*. Fleming, however, who was responsible for the name *Unio Urei*, Ure having unfortunately omitted any description of his form, describes, in his 'History of British Animals,' the shell *Unio Urei* as follows :—"Transversely oblong, dorsal margin nearly straight, unequally striated by lines of growth;" but he considered that this shell was synonymous with Martin's *Mya ovalis*, which exhibits none of the characters of *C. aquilina*. In addition Ure's shell has been erroneously referred to *Sanguinolites* by Sowerby (Prestwich, 'Geol. of Coalbrookdale,' *vide supra*, pl. xxxix, fig. 6); I say erroneously, because several Scotch geologists inform me that no marine forms ever occur in Ure's original locality. After all, on account of the confusion attaching to the history of Ure's shell, I have thought it advisable to adopt Sowerby's specific name of *aquilinus* in place of the doubtful reference to Ure. I believe that Goldfuss's *Unio atratus* and possibly his *U. tellinarius* may belong to Sowerby's species; the former has the characteristically shaped anterior end, but the oblique lines of growth are not shown, and the latter is crushed. A series of specimens, however, from the neighbourhood of Liége, which I examined at Liége, Brussels, and the British Museum (Nat. Hist.), labelled with these names, convinced me that the species were identical. I have been in doubt as to the question of priority between Sowerby's *aquilinus* and Goldfuss's *atratus*. Bound copies of 'Petrefacta Germaniæ' bear the date 1840, but the work came out in parts, commencing 1836. This coal-measure shell appears on pl. cxxxi, and its description at p. 180 was issued in the *livraison* dated "1837". Prof. Prestwich's 'Geology of Coalbrookdale' was published in 1840, and Sowerby's description of coal-measure shells was issued as an appendix to it; but the paper was read before the Geological Society on

February 5th, 1834, and on April 13th and 27th, 1836. The Assistant-Secretary, Mr. L. Belinfante, B.Sc., has kindly looked up the original minutes of these Meetings, and he finds with regard to the Meeting on February 5th, 1834, the following entry :—" The author concludes his memoir with some observations on the fossils . . . of 18 genera of shells which he enumerates ; 12 are marine." In the minute for April 27th, 1836, is found—" The fossils of the coal-measures are described with great detail." This evidence I take to be conclusive as to the priority of the name *aquilina* over *atrata*. I endeavoured to obtain accurate information as to the character of Goldfuss's shells, but Professor Schlüter of Bonn, where the originals are said to have been placed, writes me that they have either disappeared or are so fragmentary as to be unrecognisable.

I have come to the conclusion that the shell figured by Sowerby as *Unio phaseolus* is only a very young form of *C. aquilina*. The original figure agrees very closely with the shell figured on Pl. X, 19 to 42, a series of casts intended to show stages of growth, from the roof of the Hard Mine seam, North Staffordshire, in which bed the shell occurs in hundreds, the majority of the specimens being casts of perfect examples. Its anterior end is shown to be very small in the original figure, a condition which is shown specially in Pl. X, figs. 26, 33, 40. There can be, I think, little or no hesitation in referring Captain Brown's three species, *Pachyodon* or *Unio lateralis*, *bipennis*, and *sulcatus*, to *C. aquilina*. The figures of *Pachyodon* and *Unio lateralis* are those of a cast which shows the characteristically shaped anterior end, and are closely resembled by Pl. X, fig. 36. The figures of *Pachyodon* and *Unio sulcatus* show the obliquity of the lines of growth and anteriorly directed umbones, and agree in general shape with the deeper forms of *C. aquilina*, Pl. X, figs. 15, 16, 17, and 20, from Whitley ; but the figures of *Pachyodon* and *Unio bipennis* have the characteristic features of *C. aquilina*, and evidently belong to that form which possesses a blunt truncated posterior end, as Pl. IX, figs. 2, 3, and 31 ; Pl. X, figs. 20 and 23.

Professor King says, in his remarks on his new species *Anthracosia Beaniana*, " This species has some resemblance to Brown's *Pachyodon bipennis*, but it differs from the latter notably in the anterior end being much shorter," a character which a study of my figures on Pls. IX and X will show not to be of specific value. The description is very meagre, consisting of " Diagnosis : Oval, very inequilateral. Umbones small; valves thin, rather tumid, and marked with nearly obsolete wrinkles," which, unfortunately, gives no very definite characteristics. Figures only of the inner surface of the shell are given ; but in these the obliquity of the lines of growth curving over the posterior slope into the groove along the edge of the valve are markedly shown. The originals cannot be traced, unless some fragments in the Science Museum, Newcastle-on-Tyne, which Mr. Howse tells me are labelled in Professor King's handwriting, represent them. One of these

fragments is that of *C. aquilina*, showing the characteristic hinge-plate, which is the form described by Professor King as occurring in *A. Beaniana*. This hinge-plate has been necessarily modified from that occurring in other species of the genus by the obliquity of the growth of the shell, and is anything but characteristic of the genus,—in fact, I believe, from my observations, that it is peculiar to the species *C. aquilina*. I made a special visit to the shell-bearing beds at Whitley, whence Professor King obtained his original specimens, and was able to bring away with me about 100 specimens, some of which I have figured, Pl. IX, figs. 10—24, a series which shows the variable character of the shell. From a personal study of Ludwig's original specimens, kindly permitted me by Professor Geinitz at Dresden, I have no hesitation in saying that his *Unio securiformis*, *Anodonta procera*, *A. cicatricosa*, and *Unio crassidens* are synonymous with Sowerby's *C. aquilina*, and to this list Achepol has added no less than seven.

Koenen's figures of *Anthracosia securiformis* are certainly typical of the species under discussion. This author states that the originals of his figures are in the Museum of Berlin. If so, there is no label to note that the specimen has been figured, but I fully believe I saw the specimen there when I was permitted by the authorities to study all the Coal-measure bivalves. The specimens in the Berlin Natural History Museum labelled *A. securiformis* are certainly the same as those I am figuring as *C. aquilina*, but they are very large forms, and have the edge of the cardinal tooth facetted.

Large forms are rare in England, but I figure one which occurred to me in the roof of the Hard Mine at Hulme Colliery, Adderley Green, on Pl. XI, fig. 31; but this is the only one which I have seen to attain these dimensions.

The shells figured by Mr. John Ward, F.G.S. (*op. supra cit.*), possess none of the specific characters of *C. aquilina*, and should, I think, be referred to *C. acuta*. Mr. Ward has handed to me for figuring some shells of *C. aquilina* which have several small circular holes scattered over them. These holes are so regular in shape that they can scarcely have been due to erosion by plants, and so many that the probability of the cause being due to boring by some gasteropodous mollusc may be set aside. The edges of the apertures are everted, and it has occurred to me that they may have been due to the bursting through the periostracum of bubbles of CO_2 gas due to decomposition (?). Figures of two of these shells are given on Pl. XI, figs. 32 and 33.

The shell figured by Mr. Salter (*op. supra cit.*) as *Anthracosia aquilina* is very characteristic in shape and excellently drawn, showing the specific details very accurately. It is less elongated transversely, and has a comparatively greater dorso-ventral measurement than obtains in the type, and thus is more akin in shape to the form called by Professor King *Anthracosia Beaniana*.

Localities.—England: Banbury; Hard Mine, Bowling-alley Seam; roof of

Moss Coal, N.-Staff. Field; Blue Flats, Coalbrookdale; Bradford; Grains Ironstone; Brooch Ironstone; Gubbin Measures, Foxyard; Dudley, S. Staffs; Radstock;[1] Whitley, shale above Lower Main Coal, and Newbiggin; Cannock Chase; Netherton, near Morpeth, above high main seam; Horsley Wood, Wylam; 17 feet below Bensham seam; 5 feet 4 inches seam, Heworth; Beaumont seam, Newcastle-on-Tyne; roof of Shale Coal, Stanley Main, Wakefield; New Mine, Bardsley; Stubbs's Mine. Wales: S. Wales, over Four-foot, Hafod; Sychffos; Ynys Cedwin, from the Pennypieces; Bagillt, Hollywell, Flintshire. Many of these localities are copied from labels of specimens in the Museum of the Geological Survey, Jermyn Street. Scotland: Mussel-band, Kilbride; U. C. M., Fullerton, Ayrshire; Eight-foot Coal, Scoonie, Fife.

13. Carbonicola angulata (*de Ryckholt*). Plate XI, figs. 3—5.

Cardinia angulata, *de Ryckholt*. 1850, p. 104, part i, pl. vi, figs. 10 and 11.
Anodonta angulata, *Ludwig*. Päl. Urals, 1863, band x, pl. iii, figs. 9, 9 *a*.
Naiadites angulata, *Dawson*. Acadian Geology, 2nd edit., 1868, p. 243, fig. 46.
Carbonicola angulata, *Hind*. Quart. Journ. Geol. Soc., 1894, p. 441, pl. xx, fig. 14.

Specific Characters.—Shell transverse, small; anterior end rounded, moderately tumid, consisting of about one-third of the shell. The posterior end is obliquely truncate from above downwards, with the upper angle obtuse, and the inferior one rather less than a right angle. The inferior border is almost straight.

The umbones are small, elongate, with their apices pointing slightly forwards, contiguous, and prolonged backwards and downwards in an angular ridge, which terminates in the posterior inferior angle of the shell. They rise in front by a gradual tumidity, concave upwards, commencing at the anterior margin of the shell. The valves are compressed and flattened into the superior and posterior borders above the oblique ridge. Surface marked with fine striæ and lines of growth.

Interiors.—Normal; but no specimens showing the hinge have been met with.

[1] This is the only specimen of molluscan remains which I have seen from the Radstock Coal-measures, and is in the possession of Mr. R. Kidston, of Sterling. It occurs on a piece of shale with plant remains from the Upper Coal-measures of Radstock. At p. 36 of the 'Memoirs Geol. Survey Great Britain,' "The Geology of the East Somerset and Bristol Coal-fields," 1876, is a notice of the occurrence of "casts of bivalve mollusca (*Anthracoptera?*) in the coal-shale at Twerton, on the authority of Prof. Morris; and of "*Anthracosia?*" at Cammerton on the authority of Mr. McMurtrie. Owing to the high position of the beds of this Coal-field, which, according to Mr. Kidston, are the highest in England, the paucity of molluscan remains points to a change in the conditions of deposition from that which obtained in the period of the Middle Coal-measures.

Dimensions:

Antero-posteriorly	20 mm.
Dorso-ventrally	9 mm.

Locality.—Low-bottom Bed, Fulledge, Burnley.

Observations.—From the description and figures of de Ryckholt's *Cardinia angulata* I am inclined to refer the British forms to his species, to which I consider Sir Wm. Dawson's specimen of *C. angulata* from the South Joggins Coal-field also belongs, the specific name *angulata* having been given to it by him independently. I have therefore referred the specimens from Burnley to this species. The English examples, however, are somewhat larger.

I have been able to examine very few specimens of this species, all of which are from Burnley; and I have not met with the form from any other British locality.

It approaches somewhat the next species to be described, *C. similis* (Brown), in the possession of an oblique ridge and the compression above it; but the general shape and dimensions have made me hesitate to refer it to this species, and unfortunately at present no specimens have been found with the valves closed, so that the general shape of the united valves is not known.

14. Carbonicola similis (*Brown*), 1843. Plate XI, figs. 6—13, 15, 17—23, 25—27.

Pachyodon similis, *Brown*. Ann. and Mag. Nat. Hist., vol. xii, 1843, p. 393, pl. xvi, fig. 12.

Unio similis, *Brown*. Fossil Conchology, 1849, p. 178, pl. lxxiii, fig. 9.

Pachyodon nanus, *Brown*. Ann. and Mag. Nat. Hist., vol. xii, 1843, p. 392, pl. xvi, fig. 1.

Unio nanus, *Brown*. Fossil Conchology, 1849, p. 177, pl. lxxiii, fig. 7.

Non Cardinia nana, *de Koninck*. Descript. Carbonif. Anim. Foss. Belgique, 1842, p. 71, pl. i, fig. 6.

Specific Characters.—Shell almond-shaped, transversely oval, slightly oblique; anterior end elliptically rounded; narrow dorso-ventrally. Inferior border regularly convex, not interrupted by a sinus. Posterior end deeper than the anterior, and bluntly rounded in old specimens; but in young forms it is obliquely truncate from above downwards, with a somewhat acute posterior inferior angle. The superior and inferior borders are subparallel.

The umbones are moderately convex, flattened, elongated, low, and contiguous; situated about the junction of the anterior and middle thirds of the shell. They are continued downwards posteriorly to the posterior-inferior angle by a ridge, above which the shell is rapidly compressed into the superior and posterior

borders. This compression in many cases results in a sloping smooth surface, slightly concave from side to side.

The lunule is elongated and narrow. External ligament short and erect.

Valves evenly convex; in some cases flattened, in others more cylindrical. Shell thin. Lines of growth very fine, arranged concentrically. Periostracum thin; much wrinkled and folded towards the circumference of the shell.

Interior.—The posterior adductor-muscle scar is situated along and just above the ridge which passes upwards into the umbo. Hinge-plate as in *C. robusta*, Pl. II, fig. 1 *a*.

Dimensions:

	Pl. XI, fig. 6.	fig. 8.	fig. 9.
Antero-posteriorly	30 mm.	32 mm.	27 mm.
Dorso-ventrally	16 mm.	20 mm.	14 mm.
Laterally	6 mm.	13 mm.	7 mm.

Localities.—A thin band of ironstone above the Cockshead Rock. Hulme Colliery, Longton. Horizon of Banbury Coal, Bucknall. South-west of Mow Cop on the same horizon. 7-foot—Banbury? (Talk-o'-th'-Hill). All in the lower measures of the North Staffordshire Coal-field. South Staffordshire, above the Brooch Coal. Scotland—Lurgar. Springshill Colliery, Ayrshire.

Remarks.—From the figures and description I have no doubt that the species under notice is that figured by Captain Brown under the names of *Pachyodon* and *Unio similis*, the figures representing an adult form; while in his figures of *Pachyodon* and *Unio nanus* a young form is depicted. From the series of specimens which I figure in Pl. XI, figs. 6 and 7, 9—13, and 15, from the horizon of the Brooch Coal, Dudley, it appears that the characteristic shape of the adult shell is not possessed by the young, although the oblique line passing from the umbones backwards to the lower angle is always present, together with the characteristic compression of the shell above this line. In young shells, however, the posterior end is truncate and the inferior extremity acute; but in process of growth the shell expands upwards and backwards at the posterior superior angle more rapidly than it does below, so that the posterior end becomes expanded in a dorso-ventral direction, and the end of the shell itself becomes bluntly rounded.

There is also at the same time a greater expansion circumferentially, so that the adult shells are much less convex comparatively than the young. These changes by growth account for the fact that Captain Brown made two species of what I consider I have shown to be only one; and, indeed, if it were not that I fortunately was able to study a series of shells in all stages of growth, I have no doubt that I should have separated the adult and young forms into two different groups.

From my observations in the North-Staffordshire Coal-field I consider that

this species may be of value in denoting a definite horizon. I have found it to occur all round the basin, from Hulme Colliery on the south-west, along the outcrop north-east to the foot of Mow Cop, and south-west by Talk-o'-th'-Hill to Halmerend in a bed some little way above the Cockshead Rock. Though found to have a fairly wide horizontal distribution, it does not appear to occur at more than one horizon. Although in no one specimen is the whole of the hinge-plate to be seen, yet, from many specimens where portions of it are to be seen, it appears to have a fairly regular character, resembling that of *Carbonicola robusta*. Portions of the hinge are seen in Pl. XI, figs. 15, 25, and 26.

The figure of *Unio Castor*, Eichwald, 'Lethæa Rossica,' 1855–9, pl. xxxix, fig. 20, somewhat resembles the species under description; but the latter is from beds of Permian age, and I have not been able to compare the shells, so that I cannot say whether the species are the same; but certainly Brown's name has the priority.

Prof. Amalizky ('Palæontographica,' vol. xxxix, "Ueber die Anthracosien der Permformation Russlands," pl. xxii) gives figures of *Naiadites subcastor*, nov. sp., figs. 30—33; *Naiadites Fischeri*, nov. sp., figs. 34 to 39; and *Naiadites Castor*, figs. 40 to 43,—all of which show some resemblance to the adult forms of *C. similis*.

Captain Brown's description is as follows:—"Compressed, anterior side rounded; umbones hardly produced, contiguous; posterior side parallel, obliquely truncate; hinge-line straight, basal line arcuated; surface with transverse wrinkles." Both the shells *Unio similis* and *Unio nanus* are from the same locality —Middleton, near Leeds.

De Koninck gave the specific name *Cardinia nana* to a small fossil which Prof. Geinitz considers to be the same as that figured later on by Ludwig as *Cyclas nanus*; and he states that the fossil in question is an *Estheria*, and proposes that both should be placed in that group under the name of *Estheria nana* ('Neues Jahrbuch für Mineralogie,' &c., 1864, pp. 653–4; see above, p. 17).

Specimens of *Cardinia Scherpenzeeliana* (de Ryckholt, 1850) approach, very closely in form the young of Bronn's species, *e. g.* Pl. XI, figs. 10, 11, 13.

15. Carbonicola cuneiformis, sp. nov. Plate XI, figs. 24, 24 *a*.

Specific Characters.—Shell very oblique, moderately convex, wedge-shaped. The anterior end is small and compressed, but broad above. The shell rapidly becomes swollen in a posterior direction, and after attaining the maximum convexity is gradually compressed into the posterior border.

The anterior border terminates abruptly above, forming a rounded slightly

obtuse angle with the upper border; it then becomes rapidly rounded, the convexity being very acute at the junction with the inferior border, which is sinuously curved, so that the posterior inferior angle of the shell, which is very blunt, is below the level of the rest of the border. The posterior border is convexly truncate. There is a marked shallow, oblique subconstriction, which does not extend far up the shell towards the posterior end. The shell is much broader at its upper border than anywhere else. The umbones are anterior, broad, obtuse, and remote, rising rapidly in front, and posteriorly forming an acute well-marked ridge, which passes down towards the inferior angle, just above which it becomes lost on the surface of the shell.

The posterior part of the shell above this ridge is deeply channelled, the groove becoming wider and shallower as it passes backwards. The lunule is wide and flattened. The posterior ligament appears to be attached to the faces of the hinge-plate.

Interior normal. Exterior: Lines of growth very fine.

Dimensions:

Antero-posteriorly	17 mm.
Dorso-ventrally	10 mm.
Laterally	8 mm.

Locality.—Roof of the Hardmine Coal, Bucknall Colliery, North Staffordshire.

Observations.—I know only two specimens of this species. They are totally different in shape and appearance from any of the other species, and loth as I am to found a species on the occurrence of only two examples in such a variable genus, I have felt that it was impossible to refer the shell to any known form.

16. Carbonicola antiqua, sp. nov. Plate XI, figs. 28—30.

Specific Characters.—Shell moderately tumid, nuculiform, oblique. The anterior end is short and swollen, with an almost circular border. The inferior border is gently convex in front, becoming straight in the posterior two-thirds. Its posterior surface is gradually compressed, with a bluntly truncate end, which may become almost pointed at the inferior angle; the descent of the superior border is at first somewhat rapid, it is flattened above, and terminates outwards in a bluntly rounded ridge which is continuous with the umbo above, and passes downwards and backwards to the posterior inferior angle. The umbones are anterior, depressed, moderately convex, pointed forwards and contiguous. Lunule is well marked and striated. The surface is ornamented with well-marked but fine lines and striæ of growth, somewhat oblique in direction to the long axis of the shell.

Interiors normal.

Hinge-line arched, edentulous, surmounted posteriorly by a longitudinal hollow groove or elongated escutcheon, below which the ligament arises from a faint linear groove on the extreme edge of the shell.

Dimensions (fig. 29) :

Antero-posteriorly	25 mm.
Dorso-ventrally	16 mm.
Laterally	12 mm.

Locality.—Calciferous Sandstone Series, Kilminning and Kilrenny Mill, Fife; where it occurs at two horizons, one a hard shell bed in large numbers, the other a siliceous limestone with Littorina (?) Scotoburdigalensis twigs of Lepidodendron.

Observations.—I am indebted to Mr. Kirkby, of Leven, Fife, for the opportunity of studying these shells. They are interesting as occurring very low down in the Carboniferous series, and are probably the oldest form of Carbonicola known if I am right in my determination. Mr. Kirkby tells me that the late Mr. Salter referred them to Anthracosia. In support of this view, the lunule and general shape of the shell are very characteristic of Carbonicola, and I can discover no evidence of the peculiar teeth of Nucula. The shape and obliquity of the lines of growth show a relationship to *C. aquilina*, the shell of greatest range in this group, but the two forms are easily distinguished. I have visited the locality myself this summer and obtained a number of specimens, some of which showed the interior. The accessory anterior adductor muscle scar is above the anterior adductor, as in other members of this genus. The hinge is without cardinal teeth, but there is an approach towards a flattened hinge-plate seen as an expansion downwards of the edge of the shell, more easily seen in casts; the groove for the ligament is apparent, but I have not seen any specimens with the ligament preserved. In the bed at Kilrenny Mill the shell occurs in great numbers though the horizontal distribution seems limited to a few inches, and a mytiliform shell is very abundant, which I expect is the form named by R. Etheridge, jun., *Anthracoptera ? obesa*;[1] but I hesitate to refer it to this genus (Naiadites) because in addition to the striated hinge-plate it possesses a well-marked tooth in the hinge. I would point out that Mr. R. Etheridge, jun.,[2] doubtfully refers a shell from the cement stone group of Craiglockhart Hill, near Edinburgh, to *Anthracosia ?* (*Unio*) *nucleus*, Brown, to which I have alluded on p. 63, the original locality being Woodhall, Water of Leith, and it is very possible that it and the species under discussion are the same.

[1] 'Quart. Journ. Geol. Soc,' vol. xxxiv, 1878, p. 12, pl. 1, figs. 12 and 13, (14 ?).

[2] Ibid, p. 16, pl. 2, fig. 20.

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A MONOGRAPH

ON

CARBONICOLA, ANTHRACOMYA, AND NAIADITES.

BY

WHEELTON HIND, M.D., B.S.Lond., F.R.C.S., F.G.S.

PART II.

ANTHRACOMYA AND NAIADITES (ANTHRACOPTERA).

Pages 81—170; Plates XII—XX.

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17. Carbonicola elegans (*Kirkby*), 1880. Plate XX, figs. 12—15, 15 *a*.

Pleurophorus elegans, *Kirkby*. Quart. Journ. Geol. Soc., vol. xxxvi, 1880, p. 586, "On the Zones of Marine Fossils in the Calciferous Sandstone Series of Fife."

Specific Characters.—Shell transversely produced, cylindrically curved, not exceeding 25 mm. in length. The anterior end is small and much narrower dorso-ventrally than the rest of the shell. Its border is rounded in front, but hollowed out above by the lunule; it passes imperceptibly into the lower border, which is almost straight in direction, but posteriorly it rises very gently towards the posterior inferior angle. Its posterior border is rounded, the upper slope being more rapid than the inferior, and the postero-inferior angle is the most posterior part of the shell. The hinge-line is formed of two portions which meet at an obtuse angle posterior to the beak of the umbo. The upper border of the shell is swollen.

The umbones are broad and obtuse, rising gradually from the surface of the shell without any ridge anterior or posterior, but in front they are excavated by the lunule; they are situated about the junction of the anterior and second fourths of the length of the shell. The beaks are small, but curved over and pointed downwards and forwards, and terminate close to the hinge-line. The lunule is comparatively broad, and well marked. The whole shell is regularly swollen, more so above, and the valves have a rapid curvature from above downwards. The dorsal slope is somewhat flattened, and is always above the articulating hinge-line; the inner edge of the superior border is bevelled at the expense of its upper portion, forming with the opposite valve a V-shaped trench in the centre of which the valves articulate, and on either side of this articulating line is a longitudinal groove for the external ligament.

Interior.—The anterior adductor scar is almost marginal, deep and circular, the deepest part of the scar being at the upper and posterior part. The accessory adductor scar is placed above and internal to the anterior adductor; a strong umbonal rib bounds the anterior adductor behind. The posterior adductor scar is situated far back, just within the postero-superior angle of the shell; it is shallow and inconspicuous. The pallial line is simple, dotted, remote from the margin of the shell. Between the hinge-line and the superior border is a longitudinal groove in casts to receive the edge of the shell. Very obscure radiating lines are seen on the surface of casts. The hinge is a simple form of the type which obtains in *Carbonicola aquilina*. There are no anterior or posterior lateral teeth, but the edges of the hinge-line are bevelled below the umbo, the left valve being bevelled at the expense of its lower edge, to form a hinge.

Exterior.—The shell is ornamented with distinct but fine lines and striæ of growth somewhat oblique to the long axis of the shell.

Dimensions.—Fig. 15, Pl. XX, measures—

Antero-posteriorly	20 mm.
Dorso-ventrally	10 mm.

Locality.—Lower Cement-stone series, Fife; Limestone No. 10, at Randerstone, in a three-inch band of calcareous ironstone in light-grey sandy slate; in cliffs east of Pittenweem.

Observations.—This species was described by Mr. Kirkby, in his careful and accurate paper on the Marine Zones of the Calciferous Sandstone Series of the Fifeshire coast, under the name of *Pleurophorus elegans*, the generic name being given on the authority of Prof. de Koninck. He has kindly lent me a series of his fossils for study, and I have been able to examine the hinges and casts of the interior, with the result of coming to the conclusion that his shell belongs to the genus Carbonicola. The form of the hinge is practically identical with the type found in *Carbonicola aquilina*, and this differs markedly from the form found in Pleurophorus, which King states (Palæontographical Soc. vol. for year 1849, "Permian Fossils," p. 180): "Cardinal teeth two in each valve, diverging inwardly, and interlocking alternately; posterior teeth linear." Moreover, the species under discussion does not possess externally the radiating ribs on the posterior slope nor the characteristic shape, wider in a dorso-ventral direction posteriorly, which are to be seen in Pleurophorus.

Carbonicola elegans possesses characters which also are found in the other species which occurs in the Calciferous Sandstone Series, *C. antiqua*. The bevelled inner edge of the posterior border and other hinge peculiarities are similar in both, but there is no doubt that they are not the same species, differing so markedly from each other in shape and form.

Mr. Kirkby describes a faint diagonal ridge running from each umbo towards the postero-ventral angle, which I have been unable to make out in any of the specimens sent me, but otherwise his description is very accurate.

The shell more closely resembles *C. aquilina* than any other species, having in common with it the lines of growth arranged obliquely to the long axis of the shell, and the upper border of the anterior end being much below the level of the umbones; also the hinge characters are very similar; but *Carbonicola elegans* is more cylindrical, and has its umbones curved inwards, downwards, and forwards.

In the same beds with *C. elegans* only one other Mollusc is found, *Littorina Scotoburdigalensis*, but *Leperditia Okeni*, var. *attenuata*, and *Cytherella* also occur—a very similar fauna to that which accompanies *C. antiqua;* and it is very noticeable that the typical marine forms so abundant in the other shell-beds of the Fifeshire coast are conspicuously absent. With regard to the shell called

Littorina, the real generic affinities of which have never been accurately made out, Mr. Kirkby writes me that "latterly Mr. R. Etheridge, jun., thought it might be nearer Paludina." He goes on to say: "This little univalve, however, occurs sometimes with Murchisonia, Macrocheilus, and Schizodus, which are good types of marine Mollusca, besides with Bairdia, Kirkbya, Cytherella, and Leperditia, which are just as good genera of marine Ostracoda; and moreover at other times it is found with species of Carbonia, which is the most non-marine of all the Carboniferous Ostracoda." On the whole, the evidence as to the nature of the deposit is somewhat uncertain and unsatisfactory, but I am disposed to value the absence of typical marine Mollusca to a greater extent than the presence or absence of genera of Ostracods, whether marine or not.

Genus Anthracomya, *Salter*, 1862.

Synonyms:

Unio, Williamson, 1836.
— Phillips, 1839.
— Prestwich and Sowerby, 1834–36.[1]
— Goldfuss, 1838.
Anodonta, Eichwald, 1840.
Mytilus (*Modiola*), Murchison, de Keyserling, and de Verneuil, 1845.
Unio, Morris, 1843, 1854.
Cardinia, de Ryckholt, 1849.
Mytilus, de Ryckholt, 1849.
Modiola, Brown, 1849.
Unio, Brown, 1849.
— Bronn and Römer, 1852–54.
Modiolopsis (*?*), Eichwald, 1855–59.
Naiadites (*pars*), Dawson, 1860 and 1878.
Anodonta, Ludwig, 1861.
Anthracomya, Wardle, 1862.
Unio, Ludwig, 1863.
Cyrena (*Cyclas*), Ludwig, 1863.
Pleurophorus, Meek and Worthen, 1866.
Anthracosia, Geinitz, 1867.
Modiola, Römer, 1870.
Anthracomya, R. Etheridge, jun., 1877.
Anthracosia, Kinahan, 1878.
Myacites, Kinahan, 1878.
Anthracosia, Baily, 1881.

[1] This paper was read on February 5th, 1834, and April 15th and 27th, 1836, though the publication bears the date 1840.

Myacites, Baily, 1881.
Non *Anthracomya*, Hull, 1881.
Anthracosia, Achepol, 1880–83.
Anodon, Achepol, 1880–83.
Naiaditis, Barrois, 1882.
Anthracomya, Ward, 1890.
— Hind, 1893.

Generic Characters.—Shell transverse, slightly inequivalve, very inequilateral, the anterior end being small and rounded, while the posterior is produced, compressed, expanded, and generally truncate. The umbones are small and low, situated near the anterior end, very slightly raised above the hinge-line, which is straight, long, and with a cardinal and one long posterior lateral tooth in at least one species. It has a narrow interior ridge, parallel with the edge, in its posterior portion, which leaves a groove in casts. There is present a blunt oblique swelling, which arises at the umbones, and expanding as it passes downwards and backwards, becomes lost on the posterior portion of the shell. Parallel and anterior to the ridge there is an oblique shallow sulcus, which becomes expanded as it approaches the inferior margin. The ligament is small, erect, and external.

Interior.—Nacreous, smooth; pallial line simple. Anterior adductor scar deep, almost marginal, that of the accessory adductor situated above and posterior to it. The posterior adductor scar is shallow and somewhat elongate, generally situated on the posterior slope not far from the hinge.

Surface.—The exterior is ornamented with fine lines of growth and a much wrinkled periostracum.

Observations.—Although Mr. Salter does not mention the fact, figures and descriptions of shells belonging to his genus Anthracomya had been given by many authors besides Sowerby, to whom alone he refers. As far back as 1836 Dr. W. C. Williamson described a shell from the Spirorbis Limestone of Pendlebury as *Unio Phillipsii* ('Phil. Mag.,' vol. ix, p. 351), which undoubtedly belongs to this genus. Continental writers never seem to have recognised Salter's genus, though several species have been described under other generic names; but this is no doubt due to the fact that apparently few of these shells are to be obtained in the coal-fields of Europe, if one may judge by the public collections; and, although three forms—*Anthracomya carbonaria* (Bronn), *Anthracomya uniformis*, Goldfuss (generally found to be named, after de Koninck, *Goldfussiana*), and *Anthracomya minima*, Ludwig (with which the *Modiola Carlotta*, Römer, is synonymous)—are of frequent occurrence, I do not know of the presence in Great Britain of any but the last.

Mr. Salter himself, when establishing the genus, as is shown by the derivation of the name, thought that the shells he was describing had a close affinity to the Myas or burrowers of our sea-shores, and referred his new genus to the family

Myadæ; and under his observations on *Anthracomya senex* says: "We cannot get at the interior, but there is not much doubt there is a pallial sinus; and there were probably long siphonal tubes covered by a thick epidermis, the animal burrowing in the mud as most Myadæ do."[1] It is difficult to see why such a relationship should be so strongly insisted upon in the absence of direct evidence, but Mr. Salter held the view that the Coal-measures were a marine deposit, consequently the palæontology had to be fitted in to suit this opinion.

The characters on which Mr. Salter probably most strongly relied for the reference of these shells to the Myadæ are the occasional gaping of both ends (but this is not at all of constant occurrence, even in the same species) and the V-shaped markings on the type specimen of *Anthracomya senex*. He says, speaking of the shells for which he is proposing a new name (p. 230, op. cit.): "For these the discovery of a common character in the epidermis at length enables me to propose a generic name;" but beyond stating that the epidermis is wrinkled, he did not in any way say what this common character was. These markings in *A. senex* are to a large extent accidental and not specific, and this fact will be further noted under observations on this species (p. 111). But a V-shaped arrangement of the periostracum is to be found in some members of the Unionidæ[2] from abroad, and is therefore in no way peculiar to the burrowing Myacidæ. The absence of a pallial sinus, the simple Unio-like type of hinge-line, erect external ligament, absence of an internal cartilage, the position and shape of the adductor muscles, and the thickened periostracum, all point rather to a connection with the Unionidæ. In common, however, with Carbonicola, Anthracomya has the accessory adductor scars situated above and posterior to those for the anterior adductors, and not, as in recent Unionidæ, below and posterior to them.

In shape the Anthracomyæ approach the genus *Tridina* (*Mutela*) but are distinguished by the absence of the multidenticulate hinge.

There is little evidence to be obtained in favour of the view that the Anthracomya were burrowers. They are very seldom found at right angles to the stratification of the beds in which they occur, but nearly always lie parallel to them; and, further, they are always associated with byssiferous Naiadites which could not have lived buried in the mud.

All the early writers referred the shells, subsequently grouped under the name Anthracomya, to Unio, Ludwig recognising the close resemblance to Anodon by referring several forms to this genus, with which there are strong resemblances in shape and hinge-structure; but there are certain marked differences, the umbones

[1] 'Mem. Geol. Surv. Great Britain;' 'Iron Ores of Great Britain,' part iii; 'Iron Ores of South Wales,' 1861, p. 231.

[2] For example, the species named *Unio Vignonianus, U. Kleinianus,* and *Anodonta rugifera* in the Collection of recent shells in the Natural History Museum, South Kensington.

in Anthracomya being well developed compared with those in Anodon, and as far as my observations go, are never eroded. The accessory adductor muscle, too, has a different position. I have never been able to make out that Anthracomya possessed a byssus, though, in all species, the valves have a well-marked oblique sulcus and a sinuated inferior border, indicating the connection with a byssiferous ancestor, or that they themselves were byssiferous in the fry. D'Orbigny quotes a byssiferous form of Anodon, being found in the river Paraná, South America.

In my paper on the affinities of this genus in the 'Quarterly Journal of the Geological Society' (vol. xlix, 1893, p. 258), on similar grounds to those advanced here, I contended for the replacement of this genus in the family Unionidæ; but I was not aware at that time of the extent of the literature of the subject, as may be noted by the number of synonyms given.

De Ryckholt ('Mélanges Paléontologiques,' 1848) appears to have referred some forms of Anthracomya to Cardinia (Agassiz); but great uncertainty prevails about de Ryckholt's type-forms, which I am unable to trace; Professor Dewalque, of Liège, kindly showed me his collection and pointed out forms which he had named after de Ryckholt from the same localities whence the originals were obtained. In looking through the collection in the Brussels Museum I found typical Anthracomya labelled as Cardinia and Mytilus after de Ryckholt. From Mytilus, Anthracomya can easily be distinguished by the absence of the triangular, wedge-shaped form, the non-terminal position of the umbones, the absence of the scars for the byssal muscles, and the erect external ligament. Indeed, Anthracomya approaches far more closely to Modiola, to which genus Brown ('Fossil Conch.,' 1849, p. 172, pl. lxxi, figs. 24, 25; pl. lxxii, figs. 19, 20, 24, 25, 27, 29) and Römer, 1870 ('Geologie und Paläontologie von Oberschlesien,' p. 76, foot-note), refer typical shells; but Anthracomya has not the inflated anterior portion, internal ligament, byssus, or muscle-scars of Modiola, and the form and position of the umbones in either genus is markedly different. Anthracomya possesses a well-marked lunule, a character absent in the family Mytilidæ. From the sub-genus Modiolopsis, to which shells having the typical appearance of Anthracomya are referred by Eichwald, the same characters will serve as a means of separation.

Sir W. J. Dawson proposed the name Naiadites for certain Coal-measure Lamellibranchs from Nova Scotia ('Acadian Geology,' p. 43, 1860), but Mr. Salter pointed out that the group contained members of more than one genus ('Quart. Journ. Geol. Soc.,' vol. xix, 1863, p. 80), some of which he correctly referred to his new genus Anthracomya (see also 'Quart. Journ. Geol. Soc.,' 1894, vol. l, p. 437, *et seq.*; and *antea*, pp. 25, 26, and 27).

Ludwig proposed at least three names for members of the genus under notice, two of which—Unio and Anodon—need not be more than mentioned here; but it

is necessary to point out in what manner the characters of Cyclas (Cyrena) differ from Anthracomya.

Cyclas is suborbicular in shape, nearly equilateral, and possesses as dentition cardinal teeth 2—1, lateral teeth 1—1 : 2—2 ; while Cyrena has three cardinal teeth and a slightly sinuated pallial line.

The shell figured as Pleurophorus by Meek and Worthen (' Geol. of Illinois,' pl. xxvii, figs. 2, 20, p. 347) has all the appearances of *Anthracomya Williamsoni* (Brown). In the figure the position of the accessory-anterior-adductor scar is well shown, and the authors remark on the different situation of this scar in King's Pleurophorus. "It evidently differs from that species [*Pleurophorus costatus*, Brown, from the Permian] in having the scars of its pedal muscles nearly marginal and placed *directly over* those of the anterior adductors, instead of partly behind them." The surface of casts is said to show "traces of a few obscure concentric markings crossed on the posterior dorsal region by three obscure radiating costæ"—a character well seen in *Anthracomya Williamsoni*. The description and figures are perfectly typical, and I have no doubt as to the nature of the shell.

The palæontologists of the Irish Geological Survey did not accept Mr. Salter's genus Anthracomya, but referred their specimens to Anthracosia and Myacites. The Irish specimens are unfortunately not in the best state of preservation, but they exhibit characteristic features and are separated from Myacites at once by the absence of a sinuated pallial sinus.

Anthracomya and Carbonicola (the Anthracosia of previous writers) are no doubt closely related, but they are easily distinguished from one another by the absence, in Anthracomya, of the characteristic hinge-plate or hinge-teeth of Carbonicola, and by the typical expanded and broad posterior end which always obtains in this genus. It is noteworthy that a large number of Lamellibranch shells occurring with an undoubtedly marine fauna in Carboniferous rocks possess this last character; I refer to the genus now known as Sanguinolites, and this genus has the accessory-pedal muscle scars in the same situation as obtains in Anthracomya. I consider that the Anthracomyæ possess a set of characters which is an approach nearer to the Mytilidæ than Carbonicola, which again is intermediate between the Anthracomyæ and the modern Unios.

The position of the accessory-adductor muscle-scar in both Carbonicola and Anthracomya has rather a Mytiliform arrangement, more than occurs in recent Unionidæ. The traces of an obsolete byssal sinus in Carbonicola, more conspicuous also in Anthracomya; the tendency in the species of Carbonicola to have a truncate posterior end, and the universal occurrence of an expanded and truncate termination, with an oblique diagonal ridge, in Anthracomya; the longitudinally striated lunule and tooth-socket in Carbonicola,—all seem to show

along what lines the modern Unio has developed from a Mytiliform ancestor. Mycetopus from the Paraná and Amazon retains the edentulous hinge, expanded posterior end, and subparallel margins which are so characteristic of Anthracomya; Anodon also has a very strong external resemblance, but I have never seen the erosion of the umbones in any species of Anthracomya. The Anthracomyæ are, as a rule, comparatively rare, and form a very small percentage of the molluscan remains at any horizon, although in one or two beds one species may occur abundantly, in which case other shells are very seldom found. They had not, with the exception of *Anthracomya Phillipsii*, the gregarious habit of Carbonicola and Naiadites. The members of this genus are, as far as is known at present, absent in the Upper Coal-measures, with one exception, *A. Phillipsii;* and are chiefly found in the Middle Coal-measures of Lancashire, Yorkshire, and the Midlands; in Scotland, one species (*A. Scotica*) occurs in the Calciferous sandstone beds, and another (*A. modiolaris*) is found in beds of the Carboniferous limestone group, and also in those of the true Coal-measures. The so-called Lower Coal-measures of North Staffordshire really belong to the middle division, the Gannister series being represented in this area by the lower beds only of the Biddulph and Cheadle basins, where alone the fossils characteristic of the Yorkshire and Lancashire gannister are to be found. In North Staffordshire an arbitrary line is taken at the Ash or Rowhurst coal, which is said to be at the top of the Lower Measures; but there is neither lithological nor palæontological ground for this division, which should be placed, I think, more correctly, if anywhere, above the Bulhurst seam, where shales with Aviculopecten, Goniatites, Lingula, and Posidonia occur in the Pottery coal-field, and at the Stinking coal shale of the Cheadle coal-field, where a similar fauna is also to be found. Even in Lancashire, beds full of Carbonicola are to be found in the Lower or Gannister Coal-measures.

In a letter last year, Mr. Kirkby drew my attention to the close resemblance between Portlock's *Modiola Macadami* and its two varieties, and *M. subparallela*, and the shells of the genus Anthracomya. I figure two specimens, kindly lent me by Mr. Wright, of Belfast, from the Coal-measures of Ballycastle, on Pl. XVII, figs. 1 and 2, which seem to be characteristic of the form known as *Modiola subparallela*, which Portlock states in his observations also merge into *M. Macadami*. The original figure approaches very closely in contour to some forms of Anthracomya, while *M. Macadami*, especially the variety *elongata*, would seem to resemble *Anthracomya Phillipsii*. Portlock, however, goes on to say this variety approximates to *M. lingualis*, Phillips, a Mountain-limestone form. The Irish specimens occur in beds of shale with large scales of *Holoptychius Portlocki*, now *Archichthys* (*Strepsodus*) *Portlocki*.

1. ANTHRACOMYA ADAMSII, *Salter*. Plate XII, figs. 1—19.

ANTHRACOMYA ADAMSII, *Salter*. Geol. Surv. Mem. Iron Ores S. Wales, 1861, p. 230, pl. ii, figs. 7, 7 *a*, 7 *b*.

Non — — *Ward*. North Staff. Inst. Min. and Mech. Engineers, vol. x, 1890, p. 125, pl. i, fig. 2.

— — *Hind*. Quart. Journ. Geol. Soc., vol. xlix, 1893, p. 260, pl. viii, figs. 5, 5 *a*, 6, 7, 8.

Specific Characters.—Shell equivalve, obliquely and triangularly ovate, compressed all round the borders, and produced posteriorly. The anterior end is short, narrow in depth, only slightly convex, with a straight superior margin and a rounded border, the antero-superior angle being a rounded right angle. The inferior border descends rapidly, being at times slightly situated anteriorly; otherwise the outline is more or less convex. The posterior end is flattened and expanded, with a more or less truncated border. The hinge-line is straight, extending nearly the whole of the length of the shell; its umbones are broad, tumid, contiguous, raised above the hinge-line, situated in the majority of cases at about a point equal to two-fifths of the length of the hinge-line from the anterior end. The posterior slope is much compressed, and produced upwards. An oblique obtuse swelling passes diagonally backwards and downwards from the umbo, and soon becomes lost on the surface of the shell, anterior to which is an almost obsolete broad sulcus. The lunule is elongate and narrow. The cartilage is external, very small and erect. The hinge-line has not yet been observed.

The *interior* is smooth; muscular scars normal in position and arrangement.

The *exterior* is marked with fine excentric lines and folds of growth, which are crowded together at the anterior end, but diverge slightly as they pass across the shell, becoming parallel to the lower margin, the curvatures increasing in strength as they approach the posterior end, where they are reflected upwards to terminate in the superior border. Obsolete radiating lines are often seen on the posterior slope. Periostracum strongly wrinkled, shell thin.

Dimensions (Pl. XII, fig. 1):

Antero-posteriorly	65 mm.
Dorso-ventrally	45 mm.
Laterally	10 mm.

Localities.—Soap vein, Pen-y-cae, South Wales. Little Mine ironstone of Fenton and Longton, which is the same bed known as the New Mine, or Burnwood, of the more northern part of the North Staffordshire Coalfield. Horsleywood seam, Northumberland.

Observations.—Like other Coal-measure shells, the shape of *Anthracomya Adamsii* is not very constant even locally. The whole of the specimens of this

shell figured are from the Little Mine ironstone of Great Fenton Colliery, and may be regarded as typical of the various forms which the shell was capable of assuming. The chief points to be noted are the differences in the comparative measurements, and in the shape of the posterior end, which becomes in some specimens almost square (Pl. XII, figs. 6 and 9).

In my paper ('Quart. Journ. Geol. Soc.,' vol. xlix, 1893, p. 260) I made the statement that the left valve was slightly more convex than the right, a fact which I now believe to have been due to some slight dislocation of the valves after death, for the examination of a larger number of specimens has convinced me that this character was only accidentally present. Mr. Salter stated that the right valve was more convex. I have seen very few specimens indeed which afford any indications of the hinge or interior. Fig. 3, Pl. XII, however, shows a very thin hinge-line; and fig. 4, Pl. XII, is a cast of the hinge and part of the interior. The line which indicates in this specimen the junction of the valves is perfectly straight, and exhibits no flexures. In front, too, are seen on either side the accessory adductor muscle-scars, which unfortunately the artist has not indicated quite strongly enough. Some specimens (Pl. XII, figs. 3 and 10) show well-marked colour-bands.

Mr. Salter (*op. supra cit.*), in his remarks on this species, says, "A very much compressed species, with the look of a smooth Myacites—to which, in fact, it is allied;" but he does not go any further into details. The type specimen is somewhat smaller than the majority of those figured on Pl. XII, and has the subtruncate posterior end of figs. 6, 9, and 12.

Mr. Salter states that the "epidermis is moderately wrinkled in front, much so posteriorly;" but this is not a constant fact, the opposite condition obtaining in fig. 17, Pl. XII, and in fig. 19, Pl. XII, the greatest amount of wrinkling being over the central part of the shell, and the position is evidently quite accidental. With regard to the change of shape due to growth, I have figured what I take to be young forms, Pl. XII, figs. 14, 15, 16, and 13. Fig. 14 indicates the very young state, and this form occurs in large quantities with even smaller specimens, as a sort of spat bed in the Burnwood ironstone shale of Goldenhill. Figs. 13, 15, and 16 are from the same bed as the larger specimens. From a study of these it would appear that the posterior part of the shell enlarges with age at a greater rate than the anterior end, and a similar condition of growth obtains in other species of the genus. The adult form of this shell is by far the largest of all the species of this genus, and though occurring plentifully locally it is only found in the Soap vein of Pen-y-cae, South Wales Coal-field, and the Burnwood ironstone and black shale immediately above it, in the North Staffordshire Coal-field.[1] I

[1] In 'Geol. Surv. Mem. Iron Ores of Great Britain,' part 4, p. 294, *A. Adamsii* is stated to have been obtained with *A. pumila* and *A. centralis* from the Knowles Shale of Fenton and Longton, but I

know of one specimen from the Horsleywood seam of the Northumberland Coal-field. I have not met with the form in European collections. It is limited to one horizon both in South Wales and North Staffordshire. The shells are usually in a good state of preservation, and have both valves attached, showing that they are in the place where they lived. They evidently had no byssus, as they are never attached to each other or to drift-wood, and they lie chiefly parallel to the bedding planes.

The smallness of the external ligament is very remarkable, the whole of it, as shown in fig. 9 *a*, Pl. XII, only measuring 12 mm., the length of the whole hinge-line being 57 mm. Posterior to the ligament the valves came in contact, much thinned and expanded upwards. This part of the shell is very delicate, and is not often seen, owing to the difficulty of extraction from a very hard matrix.

The shell was exceedingly thin all over, and in many of the figured specimens has disappeared from the umbones; but this is accidental, and not in any sense due to erosion. It would appear from the longitudinal grooves on either side of the cast of the hinge-line that in front and for about half the length of the hinge-line posterior to the umbones the edge of the shell was produced downwards or turned on itself at a right angle to form a hinge-plate, but this must have been absent at the posterior end; and it will be noticed in fig. 4, Pl. XII, that the grooves gradually become obsolete as they pass backwards. It is probable that there is a long posterior lateral tooth in that part of the hinge-line which occupied the grooves. This gradual thinning away of the hinge-plate obtains also in the other species of this genus in which I have been able to procure casts, and is somewhat analogous to the formation of the hinge-plate in *Sanguinolites iridinoides*, M'Coy.

In addition to specimens having a comparatively elongate shape, there is a form of *A. Adamsii* which is of such constant occurrence that I considered it well in my paper in the 'Quart. Journ. Geol. Soc.' to give it a varietal name. I still adhere to this opinion, though a series of intermediate forms are to be found. This form was figured by Mr. Ward (*op. supra cit.*) under the name of *A. Adamsii*, but the shape and position of the umbones differ considerably from those of the type.

1*. ANTHRACOMYA ADAMSII, var. EXPANSA, *Hind*. Plate XIII, figs. 1—3.

ANTHRACOMYA ADAMSII, *Ward*. Trans. N. Staff. Inst. Min. and Mech. Engin., vol. x, 1890, p. 125, pl. i, fig. 2.

— — var. EXPANSA, *Hind*. Quart. Journ. Geol. Soc., vol. xlix, 1893, p. 261, pl. ix, figs. 2, 3.

think this is a mistake, as I only know this form from the Burnwood ironstone seam, in which bed, however, the other two species are absent.

Specific Characters.—Shell obliquely subquadrate, compressed, and expanded. Umbones obtuse, much nearer the anterior end than in *A. Adamsii*. The anterior end is almost obsolete and very obtuse, on which account the oblique sinus is absent. The diagonal swelling is broad, and not well differentiated from the rest of the shell. The anterior, inferior, and posterior borders form part of one general curve, which meets the inferior border posteriorly at an obtuse angle. There is no relic of a byssal notch. In other points the shell agrees with the general description of *A. Adamsii*.

Dimensions (Pl. XIII, fig. 9):

Antero-posteriorly	53 mm.
Dorso-ventrally	42 mm.
Laterally	8 mm.

Localities.—The same beds in the North Staffordshire Coal-field in which *A. Adamsii* occurs.

Observations.—From the description and figure in the 'Geology of Coalbrookdale' of *Unio dolabratus*, at first sight it might be considered that the variety under description was referred to, but owing to an imperfect example a partly erroneous diagnosis was given. Salter, in his observations on *A. Adamsii*, says that *A. dolabrata*, Sow., may be distinguished by having an almost obsolete anterior end, but he did not notice the fact, well shown in the drawing, that the anterior end was incomplete through fracture.

A. Adamsii, var. *expansa*, also differs from *A. dolabrata* in possessing a much less convex but more expanded form. Fig. 11, Pl. XII, is a form of intermediate character between *A. Adamsii* and the var. *expansa*. It possesses the general shape of the variety, but the position and shape of the umbones is very remarkable; they are more posteriorly situated than in any other specimen of *A. Adamsii* that I have met with, and are at the same time more defined, more tumid, and raised to a greater height above the hinge-line. This shell is not crushed in any way, though it was split in two in extracting it from its ironstone matrix. A large crushed specimen of the variety *expansa* which I figured in my former paper came from the shale above the Burnwood ironstone at Pitts Hill, and measured 65 mm. in length, and 55 mm. in the dorso-ventral diameter. It may be noted that at Pitts Hill, Golden Hill, and Kidsgrove the top portion of the Burnwood ironstone differs lithologically and palæontologically from the lower part. The top part consists of thin laminæ of brown and lighter coloured ironstone, passing up into a black shale, and containing *Anthracomya Adamsii* and its variety *expansa*, and a lower more compact mass without marked lines of deposition, which contains *Anthracomya pulchra* and a small Naiadites, the two forms of Anthracomya never occurring together. On the other hand, at Great Fenton I cannot make out this sharp division, and have never seen *A. pulchra* in the bed at this place.

2. ANTHRACOMYA DOLABRATA (*Sowerby*). Plate XIII, figs. 4—9 and 11.

	UNIO DOLABRATUS,	*Sowerby.*		Trans. Geol. Soc., ser. 2, vol. v, pt. 3, 1840, pl. xxxix, fig. 9.
	—	—	*Brown.*	Foss. Conch., 1849, pl. lxxxviii, fig. 17.
	ANTHRACOMYA DOLABRATA,		*Salter.*	Geol. Surv. Mem. Iron Ores of S. Wales, 1861, p. 230, no fig.
	—	—	*Hind.*	Quart. Journ. Geol. Soc., p. 261, pl. viii, 1893, figs. 9, 9 *a*, 10 *a*; pl. ix, figs. 1, 1 *a*.
Non	—	—	—	Ibid., pl. ix, figs. 4 and 5.

Specific Characters.—Shell tumid, subquadrate, transversely elongated and expanded upwards posteriorly. The anterior end is short, compressed, and comparatively narrow, its upper border being far below the umbones. The border is sharp and bluntly rounded, passing insensibly below into the lower border, which is rapidly produced downwards and backwards, being almost straight at first, but becoming bluntly rounded into the posterior border behind. The posterior border is obliquely truncate in its upper part from above downwards, rounded below. The hinge-line is straight, much raised posteriorly, equal to about five-sixths of the length of the shell in extent. The umbones are obtuse and gibbose, raised above the hinge-line, contiguous, situated at a distance equal to about one-third of the length of the hinge-line from the anterior end. The lunule is long and narrow, the shell is obliquely swollen, the tumidity being continuous with the umbones, and gradually rounded off both in front and behind. Just anterior to the swelling is a very shallow depression, which becomes wider as it progresses towards the lower margin. Posterior to the swelling the shell is gradually and regularly compressed into the border, particularly so above, to such an extent that the posterior slope of the shell is concave. The tumidity is most developed above the widest part of the shell, being just below the level of the hinge-line; downwards and backwards the swelling gradually becomes less, but it can be traced to the inferior margin some little way anterior to the posterior inferior angle.

The *interior* has not yet been exposed.

Exterior.—The shell is ornamented by fine striæ and lines of growth, which, crowded in front, become slightly separated as they pass backwards over the shell, and on reaching the oblique swelling they become deflected upwards to terminate in the superior border. Periostracum thin and wrinkled.

The ligament is external and small, but erect, equal in length to about one-fourth the length of the hinge-line. Posterior to the ligament there is a shallow,

narrow, V-shaped trench between the opposing valves, the continuation of the slight groove along the border of the shell which gives attachment to the external ligament.

Dimensions.—The type-specimen (Pl. XIII, fig. 4) measures—

	Antero-posteriorly.	Dorso-ventrally.	From side to side.
	48 mm. (restored)	29 mm. (near posterior end).	20 mm.
Fig. 5, Pl. XIII,	51 mm.	32 mm.	23 mm.

Localities.—Pennystone beds, Coalbrookdale. Little Mine (Burnwood) Ironstone, North Staffordshire. Black Mine Middle Coal-measures, Oldham, Lancashire.

Observations.—This species was one of the two members of the genus first described and figured, and I am fortunately able to refigure the original specimen through the kindness of Professor Prestwich, who has lent me the fossil for examination. The anterior end is absent, a fact which was shown in the original drawing by James de Carle Sowerby (*op. supra cit.*), the lines of growth anteriorly ending abruptly, although this incompleteness was not noted in the description, where it is stated, "Anterior side small, rounded; . . . . beaks near the anterior side." Mr. Salter, judging hastily from the figure alone, says in his original description of the genus Anthracomya, "*A. dolabrata* (Sow.) is still more convex [than *A. Adamsii*], and has an almost obsolete anterior side" (*op. supra cit.*).

Anthracomya dolabrata is very closely allied indeed to *A. Adamsii*, and in North Staffordshire the two species are found together in the Burnwood Ironstone. On the other hand, there is a strong resemblance to certain large forms of *A. modiolaris*, so that it forms a connecting link between these species.

From *A. Adamsii*, *Anthracomya dolabrata* differs in its much greater convexity, being the most gibbose species of this genus, by the greater tumidity and height of the umbones. The greatest thickness is subumbonal, not as in *A. Adamsii* about the centre of the shell; and relatively the antero-posterior measurement is greater than in *A. Adamsii*. But forms occur intermediate in shape and character between the two,—for example, fig. 6, Pl. XIII.

I have seen nothing in Continental museums which can be considered at all like the species under description; and, indeed, the shell has been very little noticed by palæontologists. Salter dismisses it in one line, and Captain Brown simply copied Sowerby's figure, giving a very inaccurate description, and stating the locality as Coalbrookdale. It is very evident that he never saw any specimen of the shell in question.

In my paper "On the Affinities of Anthracoptera and Anthracomya" ('Quart. Journ. Geol. Soc.,' vol. xlix, p. 261) I re-described the species from the type kindly lent for that purpose by Prof. Prestwich, and I then stated that certain

specimens from Oldham and Longton were somewhat different in appearance. These shells are now re-figured on Pl. XIII, figs. 10 and 12, but from a further study I have come to the conclusion that they more closely resemble *A. modiolaris* in the stronger ridge-like oblique swelling, deeper sinus, and less produced form, and I have therefore now referred these two shells to that species. I have been able to procure only two other specimens from the original locality, Coalbrookdale, but unfortunately both of them are even less perfect than the type. There are, however, three in the Museum of the Geological Survey from the same place which have the characteristic features. These I have been allowed to examine by the courtesy of Mr. E. T. Newton. The shell figured on Pl. XIII, fig. 14, from Old Cummock, seems to be intermediate in form between the species under discussion and *A. modiolaris*, to which I have referred it on account of the nearly parallel dorsal and ventral margins. *A. dolabrata* is much more transverse, convex, and less expanded than *A. Adamsii*, with which shell it occurs in the Little Mine ironstone of North Staffordshire.

3. Anthracomya modiolaris (*Sowerby*). Plate XIII, figs. 10 and 12; Plate XIV, figs. 1—11 and 32; Plate XVI, figs. 49—53.

Unio modiolaris, *Sow.* Trans. Geol. Soc., vol. v, pt. 3, 1840, pl. xxxix, fig. 10 *bis*.
Modiola curtata, *Brown.* Foss. Conch., 1849, pl. lxxii, figs. 19, 20.
— Robertsoni, *Brown.* Ibid., pl. lxxii, figs. 24, 25.
Unio modiolaris, *Brown.* Ibid., pl. lxxxviii, figs. 5, 6.
Anthracomya modiolaris, *Salter.* Mem. Geol. Surv. of Great Britain; The Iron Ores of Great Britain, pt. 3, 1861, p. 230, pl. ii, fig. 13.
— — *Ward.* Trans. North Staff. Inst. Min. and Mech. Engin., vol. x, 1890, pl. i, fig. 10.
— — *Hind.* Quart. Journ. Geol. Soc., vol. xlix, 1893, p. 265, pl. x, figs. 24—26.
— dolabrata (pars), *Hind.* Ibid., pl. ix, figs. 4 and 5.
— sp. nov., *Hind.* Ibid., p. 271, pl. x, fig. 23.

Specific Characters.—Shell transversely elongated, trapezoidal, convex. Dorsal and ventral margins appear to be sub-lateral in casts, but occasionally the posterior part of the shell is produced upwards and compressed. The anterior part of the shell is small and bluntly rounded, the upper border being much below the level of the umbones. The curvature of the anterior border varies, but the anterior superior angle is always the most anterior point of the shell. The inferior border is straight for the greater part of its extent, becoming bluntly rounded at

its junction with the posterior border. The posterior border is markedly truncate from above downwards and backwards, making an obtuse angle above with the hinge-line, which is rarely rounded; the posterior inferior angle is the most posterior portion of the shell. The hinge-line is straight, extending the whole length of the upper border, directed somewhat obliquely upwards behind, so that it really never is parallel to the lower border on account of its low situation at the commencement. The umbones are obtuse, tumid, and contiguous, only slightly raised above the hinge-line, somewhat excavated in front by the lunule, which is narrow and elongated, and bevelled off posteriorly. Proceeding from the umbones downwards and backwards across the surface of the shell is a blunt oblique ridge or swelling, which gradually becomes less conspicuous as it approaches the margin of the shell near the posterior inferior angle. This oblique swelling is sometimes acute and subangular, at others equally rounded. Anterior to this gibbosity the shell is compressed, the compression becoming broader as it approaches the lower margin. Posterior to the oblique swelling the shell is expanded and rapidly compressed, especially in an upward direction, so that the posterior slope may be slightly concave.

Interior.—Pallial line entire; anterior adductor scar marginal, shallow. Posterior adductor scar obscurely marked, large, situated near the posterior superior angle of the shell. I only know of one example showing the hinge, and that, a left valve. The hinge consists of two portions—a short anterior part, which does not appear bevelled, which stops abruptly just anterior to the apex of the umbo, and is separated from the posterior part of the plate by a gap, possibly for the reception of a cardinal tooth in the right valve. Posteriorly, commencing just under the umbo, is a long narrow lateral tooth, formed by the lower edge of the hinge-plate, above which is a shallow elongate groove; above this is the thin raised upper edge of the hinge-plate, outside which is the elongate narrow groove, parallel to edge of the shell, characteristic of the genus.

Posterior to the lateral tooth the edge of the hinge-plate is raised and bent on itself, and bevelled to come in contact with a similar surface in the opposite valve.

Exterior.—The surface is marked with fine lines and striæ of growth, which have a concentric arrangement parallel to the margins of the shell, more densely crowded at the lower margin and in front; periostracum wrinkled. Shell thin.

Dimensions:

	Antero-posteriorly.	Dorso-ventrally.	Laterally.
Fig. 1, Pl. XIV . .	44 mm.	23 mm.	18 mm.
Fig. 9, Pl. XIV (Mr. Salter's type)	31 mm.	18 mm.	14 mm.
Fig. 49, Pl. XVI (Sowerby's type)	40 mm.	15 mm.	13 mm.

Localities.—England: Roof of the Holly Lane at 10-foot Seams, North Staffordshire; Crawstone, Coalbrookdale; Black Mine, Oldham; Cowpen Colliery and

Whitley, Newcastle and Durham Coal-field; Grain's Ironstone, South Staffordshire; Stubb's Mine, Bardsley. South Wales Coal-field: Sychffos; Darren Pins, Aberdare. Scotland: Splint Coal, Shettleston, Ardrie, and Larkhall; Annandale, Kilmarnock, Old Cummock, Ayrshire,—all in the Upper and Middle Coal-measures.

Observations.—Owing to the fortunate preservation of the types of this shell and the specimen subsequently figured by Salter, I have been able to reproduce them by the kindness of Prof. Prestwich and of Sir A. Geikie, Director-General of the Geological Survey, and with the exception of two synonyms invented by Captain Brown and a mistaken reference by myself this shell has always been recognised by authors. I figure these shells from Prof. Prestwich's Coalbrookdale Collection on Plate XVI, figs. 49 and 50 representing the two specimens figured by Sowerby (*op. cit. supra*) as his fig. 10. I judge from measurements, and from the fact that Prof. Prestwich has marked both specimens as figured, that the two figures numbered 10 in the 'Geology of Coalbrookdale' are from different specimens, one showing the view from above, the other and larger one from the side. These are both more elongate than Mr. Salter's form, and have the dorsal and ventral margins more nearly parallel; but with these in Prof. Prestwich's Collection is a shell from the same locality figured on Pl. XVI, fig. 51, which is almost identical in form with Mr. Salter's shell, showing that in the young the shell had a more triangular shape. I produce on Pl. XIII, fig. 9, the shell which was the original of Mr. Salter's figure in the 'Geological Survey Memoir on the Iron Ores of South Wales.' This is also a cast, but it shows no muscle-scars, except the anterior adductor very faintly on the left side.

From the series figured from North Staffordshire it will be seen that the shape and degree of acuteness of the oblique ridge is very variable, and also the amount of expansion upwards of the posterior part of the hinge-line. This may, I think, be due to the fact that the types are all casts, and that the thin part of the valves which came absolutely into contact with each other would therefore not be indicated in casts. All the shells, it may be noted, which have this character possess more or less shell-structure preserved. Thus fig. 10, Pl. XIII, and figs. 1, 7, and 8, Pl. XIV, all show the posterior part of the hinge-line expanded upwards.

I have been fortunate enough to obtain a nearly perfect example of the hinge of this species, only the extreme anterior and posterior positions being wanting. This specimen, which is figured on Pl. XVI, fig. 52, came from the same bed at Whitley, Northumberland, where Prof. King obtained the hinge-plates on which he founded his genus Anthracosia, and shows a characteristic posterior lateral tooth, and a small cavity under the umbo, probably to receive a cardinal tooth of the opposite valve.

Whether these conditions obtain in other species is at present unknown.

Casts of *A. modiolaris* show no indication of teeth of any description, and have exactly the same characters as casts of the other species of this genus. It is, therefore, not safe to come to any conclusion as to the absence of hinge-teeth in other forms from an examination of the casts alone.

This species is easily recognised by its narrow-elongate gibbose form. It is much narrower in a dorso-ventral direction than any of the foregoing species, and can be distinguished from *A. Williamsoni* by its greater gibbosity and more pronounced oblique ridge; it generally, too, attains a greater size. These two shells do not, according to my experience, occur together. In North Staffordshire each species is limited to its own bed, *A. modiolaris* occurring in the roof of the Holly Lane Coal, an horizon some little way above the Hard Mine, where *A. Williamsoni* occurs. In Scotland the species occurs in very typical forms in the Upper Coal-measures of Lanark and Ayrshire. Mr. Etheridge, jun., stated that it was the only member of the family recognised in Scotch beds, and, indeed, it seems to be the most common. (Presidential Address, Royal Physical Soc. of Scotland, the 'Palæozoic Conchology of Scotland,' 1882, p. 50.) He says, "It is confined to the Coal-measures, and the Middle Coal and Ironstone Series." In these beds *A. modiolaris* always occurs in the form of casts. The figure of Capt. Brown's *Modiola curtata* is very similar to the specimens figured on Pl. XIII, fig. 10. There are some specimens of the same form in the Owens College Museum, locality not stated, but probably from Lancashire beds, as I know the form from the horizon of the Black Mine, Oldham. Captain Brown's specimen came from Wakefield. His figure is, I think, one of a somewhat truncate form of *A. modiolaris*, but owing to the fact that I have been unable to see many specimens I have not considered it wise to give a varietal name to these shells. Should it be shown in the future that the form exists as a well-marked local or horizontal variation, Capt. Brown's name might be given as a varietal name, *A. modiolaris*, var. *curtata*.

It is rather more doubtful whether (judging from the figure alone) *M. Robertsoni*, Brown, should be considered as a synonym of *A. modiolaris*, but the description, when correct according to the figure, agrees very well. "Elongated, inflated; beaks subcentral (which they certainly are not in the drawing), obtuse, rounded. Hinge-line short (not so in the drawing). Surface smooth, with remote shallow lines of growth." If the original was intended for a member of this genus, I know no species to which it bears more resemblance than the one under discussion, and *A. modiolaris* occurs in the Newcastle-on-Tyne Coal-field, the locality from which Captain Brown obtained his shell.

I figure on Pl. XIII, fig. 14, a large shell from the Collection of Mr. J. Smith, of Kilwinning, obtained from Old Cummock, which is probably a giant form of *A. modiolaris*. He has lent me a slightly larger one, which measures 60 mm.

antero-posteriorly, its greatest dorso-ventral measurement (towards the posterior end) is 32 mm., and 22 mm. from side to side: this specimen is more typical in shape than the one figured. I noted also in the Museum at Brussels a large example measuring 54 mm. from before backwards, from the Coal-measures of Longchamps, but have not met with the form in other Continental museums.

4. Anthracomya Williamsoni (*Brown*). Plate XIV, figs. 12—31; Plate XV, fig. 10.

? Anodonta tenera, *Eichwald*. Urwelt Russlands, p. 101, pl. iv, figs. 2, 3, and 4, 1840.
? Mytilus (Modiola) Teplofi, *de Verneuil*. Géol. de la Russie, vol. ii, p. 318, pl. xix, fig. 17, 1845.
— præpes, *de Ryckholt*. Mélanges Paléontologiques, p. 158, 1e part, pl. viii, figs. 1, 2, 1848.
Modiola Williamsoni, *Brown*. Fossil Conchology, pl. lxxi, figs. 24, 25, p. 172, 1849.
Modiolopsis tenera, *Eichwald*. Lethæa Rossica, p. 977, pl. xxxix, fig. 4, 1855–9.
— Teplofi, *Eichwald*. Ibid., p. 978, 1855–9.
Anthracomya sanguinolaris, *Salter*. Memoirs of the Geological Survey of Great Britain, "The Geology of the Country around Bolton-le-Moors," p. 35 (no description or figure), 1862.
Anodonta tenera, *Ludwig*. Pal. Urals; Palæontographica, vol. x, p. 20, pl. iii, fig. 13, 1863.
Anthracosia Weissiana, *Geinitz*. N. Jahrbuch für Mineralogie, &c., 1867, p. 682.
Pleurophorus subcostatus, *Meek and Worthen*. Geol. Surv. Illinois, vol. ii, p. 347, pl. xxvii, figs. 2, 2 *a*, 1866.
Anthracosia Bilboensis, *Kinahan*. Geol. of Ireland, pl. iv, fig. 5, 1878.
— — *Baily*. Geol. Surv. Ireland, Exp. of Sheet 137, p. 12, 1859.
— Harzi, *Achepol*. Niederrheinisch-Westfalische Steinkohlen-Gebirge, Atlas, p. 109, Supplement ii, figs. 8 and 9, 1880—1883.
Anthracomya elongata, *Hind*. Quart. Journ. Geol. Soc., vol. xlix, p. 266, pl. x, figs. 1—12, 1893.

Specific Characters.—Shell very transversely elongate, very inequilateral, wedge-shaped, and compressed. The anterior end is small, narrow from side to side and above downwards, with an acutely rounded border, which passes downward rapidly into the inferior border, and forms above a blunted right angle with the hinge-line. The posterior end is expanded and produced, and is gradually compressed into its borders, but much more rapidly so upwards into the hinge-line. The inferior border is nearly straight, but is slightly sinuated about its centre. The posterior border is truncate, with the upper and lower angles more or less rounded. The hinge-line is straight, raised, and compressed

posteriorly, rather shorter than the length of the shell. The umbones are small, contiguous, very slightly raised above the hinge-line, and situated at rather less than one third the length of the hinge-line from the anterior end. The lunule is narrow and elongated.

A broad obtuse gibbosity passes from the umbones diagonally across the shell towards the posterior inferior angle, but becomes lost on the surface before reaching that point. Anterior to the swelling is a shallow oblique sulcus, which becomes very broad at the inferior margin, and corresponding in position to the sinuosity. The superior and inferior borders are subparallel in medium-sized and small specimens. The greatest dorso-ventral measurement is at or only slightly in front of the posterior end.

Interior.—Normal. The anterior adductor scar is shallow and marginal, the accessory pedal scar punctiform in the usual situation. The posterior adductor scar is rarely seen, owing to its shallowness and want of definition as to its margin.

The surface of casts is marked by broad shallow sulci and fine radiating lines at the anterior end and on the posterior slope. There is an elongate groove in casts on either side of the line which marks the union of the valves posteriorly for a short distance to receive the edge of the shell, which is there expanded downwards at a right angle to itself to form the hinge-plate.

Exterior.—The surface is almost smooth, covered with very fine concentric lines of growth, which, crowded at their origin in front, become parallel to the inferior border as they pass across the shell till they reach the diagonal swelling, when they become reflected upwards at a rounded right angle towards the superior border. The shell is very thin and seldom preserved.

Dimensions.—Fig. 12, Pl. XIV, measures—

Antero-posteriorly	35 mm.
Dorso-ventrally	17 mm.
Laterally	5 mm.

Localities.—The roof of the Hard Mine Coal, North Staffordshire. Alldene Colliery, Gateshead. Brown's specimen is said to have come from Wakefield. High up in the Gannister series of Burrs, half a mile north of Bury, Bolton. South Wales. Mine over the Three-quarter coal, Ebbw Vale. Eastfield, Upper Coal-measures, Scotland. Ireland: Four-foot bed of shale over Coal III (Three-feet or Old Colliery coal), Bilboa and Castlecomer.

Observations.—I find in Captain Brown's 'Fossil Conchology' (*op. supra cit.*) a shell, which closely resembles in form those under description, under the name *Modiola Williamsoni*. He refers it to *Modiola elongata*, Williamson, MS., but gives no reason for the change of name. I unfortunately chose the latter name in preference to that of *Williamsoni* in my paper on *Anthracomya* (*op. supra cit.*), and have now to discard it in favour of the former, because the name *A. elongata*

was given by Professor Sir G. W. Dawson to a shell then named by him *Naiadites*, but now recognised as *Anthracomya* ('Q. J. G. Soc.,' vol. l, p. 437, pl. xx, figs. 7—10), but of a totally different species from that under discussion.

Judging from the description and figure of Eichwald's *Anodonta* (*Modiolopsis*) *tenera*, it is possible that it may turn out to be identical with *A. Williamsoni*, and this author's description of the form is as follows:—"Sehr dünn, aber weniger flach, sondern eher gewölbt und concentrisch gestreift, das eine Ende weit breiter, als das andere mehr zugerundete, der wirbel flach, wenig hevorstehend der schlossrande grade; beide Schalen hängen durch das Schloss von dem einen Ende bis zum andern zusammen wie dies bei Anodonten der Fall zu sein pflegt;" but it is impossible to be certain, without an examination of the shells, whether *Modiolopsis tenera* belongs to *Anthracomya Williamsoni* or *A. Wardi*, which it seems to resemble in its posterior border. I am strongly of the opinion that one of these two species will be found to belong to Eichwald's form, and in that case his name will have the priority. But there is still another uncertainty as to the name, for it is also possible that the species under description may be shown to be identical with *Mytilus* (*Modiola*) *Teplofi*, Murchison, de Keyserling, and de Verneuil, 'Paléontologie de Russie,' vol. ii, p. 318, pl. xix, fig. 17 (1845), the descriptions and figure agreeing very closely; but not having seen the shell it is difficult to speak certainly. This name is also prior to that proposed by Captain Brown; and should it be found that *A. tenera* of Eichwald is identical with *A. Wardi*, then, if *M. Teplofi* be different in any way from *A. tenera*, it may be necessary to substitute de Verneuil's name for that of Captain Brown. Eichwald, in 'Lethæa Rossica,' 1855–9, pp. 977 and 978, also gives a good description of the shells *M. Teplofi* and *M. tenera*, and in almost identical language, so that each description might well do for the other; in addition both forms are said to come from the same locality—the coal-measures of Lissitschanskaya county of the Cossacks of the Don. It may be noted here that the form and comparative dimensions of *A. Williamsoni* are very variable. *Mytilus Teplofi* is said to occur in the coal-mines of Lissitchia Balka (Donetz), below the limestone with *Spirifer mosquensis*, but whether the bed is marine or no is not stated.

Ludwig simply followed Eichwald with regard to *Anodonta tenera*, but more correctly retained his first generic reference.

I was able to examine the specimen to which Mr. Salter gave the name of *Anthracomya sanguinolaris* in his palæontological notes to the Survey Memoir on the country around Bolton. It is preserved in the Museum of the Geological Survey at Jermyn Street, and I have no doubt that this shell belongs to the species under description. Another member of the genus *Anthracomya* occurs near the same horizon, but in a different matrix. This one, however, I believe to be *A. Wardi*.

I had the opportunity, for which I thank Professor Geinitz, of examining the originals of his *Anthracosia Weissiana*, from the Saarbrücke Coal-field in the Dresden museum (*op. supra cit.*), and have no hesitation in referring that shell to the British form. Achepol's *Anthracosia Harzi*, from the Hannebal group *Bochum*, is doubtless the same shell; and, if I am correct in my surmise that the Russian form is also identical, it is interesting thus to trace the shell right across Europe.

Judging from the description of *Pleurophorus subcostatus* of Messrs. Meek and Worthen, I think it highly probable that their shell belongs to the species under discussion. I have quoted from their description *antea*, p. 87, to show that they lay stress on some of the characters which I consider typical of Anthracomya. It is said to occur in the Upper Coal-measures of Gallatin County, Illinois.

The *Anthracosia Harzi* of Achepol is, I think, a specimen of *A. Williamsoni*; curiously enough, this shell is not figured in the body of the work as a photograph, but is only in a supplement, which consists of a series of engraved figures of the shells previously described, but it is not stated if the shells are drawn from real specimens or are from restorations, and intended to give a general indication of the size and shape.

Anthracomya Williamsoni varies very much in the shape of the posterior end and in its comparative measurements. At times the posterior border is truncate, at others bluntly rounded, or the inferior angle may be at times somewhat prolonged, so that it may become a right angle or even slightly acute. Many specimens show a typically gaping posterior end, and as many, on the other hand, have the valves close all round. I have not been able to satisfy myself that there has been any dislocation of the valves or eversion of the shell due to pressure or injury in those specimens which gape, and am inclined to believe that in some individuals the valves gaped and in others the valves were closed. The same conditions are to be observed in the marine fossil *Sanguinolites* (*?*) *sulcata*, the *Sanguinolaria sulcata* of Phillips, from the Redesdale ironstone, some specimens of which shell appear to have widely gaping posterior ends, and others to be closed all round.

In my notes made at the Natural History Museum of Brussels I have it that the specimen labelled there *Mytilus præpes*, de Ryckholt, is the same species as *A. Williamsoni*. The original drawing does not, however, show a very close resemblance, but the description is fairly characteristic. The original specimen was from the coal shale of Mons, the one I saw was from Longchamps.

4*. Anthracomya Williamsoni, var. obtusa, *Ludwig*. Plate XV, figs. 5—9.

Unio obtusa, *Ludwig*. Palæontographica, vol. viii, p. 33, pl. iv, figs. 13—15, 1859-60.

Anthracomya obtusa, *Hind*. Quart. Journ. Geol. Soc., vol. xlix, p. 267, pl. x, figs. 14, 14 *a*, 1893.

Varietal Characters.—The shell is quadrately oblong. The anterior end is almost obsolete, constricted anterior to the umbonal fold, its border blunt and obtusely rounded. The dorsal and ventral margins are almost parallel, the inferior border straight. The posterior end is truncate, the upper and lower angles being bluntly rounded. The hinge-line is curved anteriorly as far as the umbo, but posteriorly is straight and slightly elevated. The umbones are almost anterior, not contiguous, small, hardly raised above the hinge-line. The posterior part of the shell is elongated and flattened. The upper border of the posterior umbonal ridge is prolonged backwards and downwards, but very soon becomes lost on the surface of the shell; above this line the shell is compressed into the hinge-line.

Interior normal.

Exterior.—Surface-markings as in *A. Williamsoni*.

Dimensions :

	Antero-posteriorly.	Dorso-ventrally.	Laterally.
Pl. XV, fig. 5, measures . .	25 mm.	12 mm.	8 mm.

Locality.—With *A. Williamsoni* in the roof of the Hard Mine Coal of North Staffordshire.

Observations.—This form occurs sparingly with specimens of *A. Williamsoni*, and only differs from that shell in the anterior position of the umbones and obsolete anterior end, and in consequence has a less conspicuous oblique ridge, and is generally less convex, and more flattened. The shell I show (Pl. XV, fig. 5) agrees in every character with the figure and description of *Unio obtusus*, Ludwig. Seeing how the position of the umbo varies in many of the species of this genus, and that the varietal form is always found associated with *A. Williamsoni* as far as I am aware at present, I have not thought it advisable to perpetuate Ludwig's name as that of a specific form, but have adopted it as denoting a fairly constant and well-marked variety.

The varietal is much rarer than the specific form, and I should estimate that it is not met with more frequently than in the proportion of 1 in 40.

5. Anthracomya lanceolata, *Hind.* Plate XV, figs. 11, 11 *a*.

Modiola lithodomoides (on the authority of R. Etheridge, sen.), *Ward.* Trans. North Staff. Inst. Min. and Mech. Eng., vol. x, p. 130, pl. i, fig. 11, 1890.

Anthracomya lanceolata, *Hind.* Quart. Journ. Geol. Soc., vol. xlix, p. 267, pl. x, figs. 13, 13 *a*, 1893.

Specific Characters.—Shell very narrow dorso-ventrally, much elongated transversely. Almond-shaped; dorsal and ventral margins parallel. The anterior end is much lower than the umbones; short and convex, its upper border straight, but directed obliquely upwards, rounded below. The inferior border is straight for the anterior fourth of its length, then slightly sinuated, after which it is produced backwards and very slightly downwards, till it curves bluntly upwards, to pass gradually into the posterior border, which is acutely pointed at its centre by a descent of the superior end and rise of the inferior border. The hinge-line is straight, extending about four-fifths of the length of the shell, not raised posteriorly. The umbones are small, only just raised above the hinge-line, not contiguous, situated at a point one-sixth the length of the shell from the anterior end. The lunule is narrow and elongated. The shell is moderately convex in its anterior two-thirds, being gradually flattened above, below, and posteriorly in the hinder third. There is a well-marked constriction, becoming broader and shallower towards the inferior margin, which it indents, in the anterior part of the shell, and an almost obsolete oblique ridge can be traced continuous with the upper border of the umbonal ridge towards the centre of the posterior end.

Interior.—The surface of the cast is smooth. Anterior adductor scar marginal, large; posterior scar not apparent.

Exterior.—Surface covered with fine lines and flattened laminæ of growth which are parallel to the inferior and posterior margin, and therefore sharply angulated or curved behind, before they pass upwards and forwards to terminate in the upper border.

Measurements.—The type specimen measures—

Antero-posteriorly	32 mm.
Dorso-ventrally	10 mm.
Laterally	7 mm.

Locality.—Horizon uncertain. The type specimen was given me by a collier, who stated that he had picked it up at the Glebe Colliery, Fenton, where a number of seams in the Middle Coal-measures are worked.

In my original account of this species I gave the Bowling Alley Seam as the horizon of a second specimen figured now on Pl. XV, fig. 20, but which evidently should be more correctly referred to *A. Wardi*.

Observations.—This species is founded on a single specimen, and I have met with no shell at all like it in any of the Collections I have examined in the British Isles.

The form is distinct from all others, the one most closely approaching it being the elongate variety of *A. minima*, to which I have given the name *A. minima*, var. *carinata*, but this species is more carinate and smaller.

Mr. Robert Etheridge, F.R.S., referred my shell to *Modiola lithodomoides* (R. Etheridge, jun.), and it was on this authority that Mr. John Ward figured it under this name (*op. supra cit.*). *Modiola lithodomoides*, a species probably synonymous with *Mytilus cordiolianus*, de Ryckholt, is a much larger shell found in the typically marine beds of the Mountain Limestone, and possesses marked modioliform characters, which are conspicuously absent in *A. lanceolata*. It is impossible to confound the two shells if they are compared, as they have little or nothing in common.

6. ANTHRACOMYA WARDI, *Salter*, MSS. Plate XIII, figs. 13, 15, 16; Plate XV, figs. 1—4, 12—20.

ANTHRACOMYA WARDI, *Ward*. Trans. North Staff. Inst. Min. and Mech. Engin., vol. x, p. 126, with description by R. Etheridge, F.R.S., 1890.

— — *Hind*. Quart. Journ. Geol. Soc., vol. xlix, p. 271, pl. ix, figs. 9 and 10, 1893.

— ANGUSTA, *Hind*. Ibid., p. 268, pl. x, fig. 15, 1893.

Specific Characters.—Shell transversely oblong, with the upper and lower margins almost parallel, slightly convex.

The anterior end is short, comprising about one quarter of the shell; its border forms a right angle above with the hinge-line, but it is rounded below, and passes into the inferior border in one gradual curve. The inferior border is straight, and inclined very slightly downwards as it passes backwards. The posterior border is blunt, very slightly truncate from above downwards. The upper part is sinuated, so that the posterior superior angle of the shell is a right angle. The posterior inferior angle is blunt and rather less than a right angle. The hinge-line is straight, extending the whole length of the upper border, not elevated posteriorly.

The umbones are flattened, small, and inconspicuous, hardly raised above the hinge-line, and are situated in the anterior third of the shell. A blunt, oblique tumidity extends from the umbonal area backwards and downwards towards the

posterior inferior angle, gradually diminishing in intensity as it passes in this direction; anterior to the oblique timidity the shell is flattened. Posterior to and above the swelling the shell is compressed and flattened into the hinge-line, the flattened portion often being traversed by obscure radiating lines, especially well marked in the young state.

Interior.—Not known at present.

Exterior.—The surface is covered with lines and striæ of growth, well marked and distinct and crowded anteriorly, becoming almost obsolete posteriorly, so that the posterior portion of the shell is almost smooth. The striæ run parallel to the inferior and posterior margins, and terminate above in the hinge-line somewhat obliquely. The periostracum is wrinkled.

Dimensions:

	Antero-posteriorly.	Dorso-ventrally.
Fig. 13, Pl. XV, measures	40 mm.	16 mm.
Fig. 18, Pl. XV „	30 mm.	10 mm.

Localities.—North Staffordshire: the shale over the Bowling Alley Coal[1] at Adderley Green, Bucknall, and Whitfield. Fulledge, Burnley. High up in the Gannister series at Burrs, half a mile north of Bury, Lancs. Roof of Shale Coal, Wakefield.

Observations.—This species was founded upon a comparatively poor specimen in the cabinet of Mr. John Ward, F.G.S., of Longton, by Mr. Salter, who, however, published no description; but this omission was made good by Mr. R. Etheridge, F.R.S., in Mr. Ward's book on the 'Geology of the North Staffordshire Coal-field' (*op. supra cit.*). This specimen I am able to figure on Pl. XV, fig. 14, by the kindness of Mr. John Ward. As I pointed out in my redescription of this fossil (*op. supra cit.*), Mr. Etheridge described the specimen with the preconceived idea that the shell belonged to the Anatinidæ, and that he mistook an imperfection for a central umbo, and somewhat unwisely surmised the shell to possess characteristics belonging to the genus Anatinidæ, which could not be seen in a single imperfect valve. The specimen is altogether too imperfect to serve as a specific type, but I believe that enough has been left of it to show that the shell belongs to a distinct species, of which I have been able to procure good examples. The typical posterior end of Mr. Ward's specimen is well preserved, and there can be little or no doubt that it is a similar shell to Pl. XV, fig. 13, from the Kay Shuttleworth Collection of the Manchester Museum, Owens College, which probably has attained a similar stage of growth. The other specimens from the same Collection, Pl. XV, figs. 16, 17, and 19, and the beautifully preserved

[1] Mr. Ward gives the Holly Lane seam, but I think it is more probably the Bowling Alley, the next seam above which is overlain by a shell-bed. The two seams are always worked together, and the rubbish would be on the same tip.

specimen from the Collection of Mr. George Wild, fig. 18, show what I take to be younger forms of the same species, the general shape of the shell being the same, but young forms have a sharper oblique ridge and radiating lines on the posterior slope of the shell above the oblique ridge. The typical blunt, truncate posterior end, sinuous above, is common to both the young and adult state.

M. d'Eichwald's figure of *Modiolopsis tenera* differs from *Anthracomya Wardi* in being shorter, whilst no mention is made of the oblique compression and blunt ridge, though the outline of the posterior border is very similar.

The specimen from the Holly Lane Shale at Whitfield (Pl. XV, fig. 20) possesses the characters of the young shells. The study of a series has convinced me that the shell that I described in 1893 (*op. cit. supra*) as *Anthracomya angusta* is only a very young specimen of *A. Wardi*. I refigure this specimen on Pl. XV, fig. 12; and, from a closer examination of the matrix, doubt its having come from the Hard-mine bed, several shell-bearing beds being mixed on the tip heap where I met with the specimen. I have figured on Pl. XIII, figs. 13, 15, and 16, two shells from the coal shale of Wakefield, which I take to belong to this species. The extreme posterior end has not been preserved; but if one may judge from the direction which the lines of growth take in the posterior part of the shell, it would correspond with that possessed by the type. It is possible that they may, in the future, when more specimens are obtained, be shown to be distinct. Pl. XIII, fig. 15, I have with hesitation referred to this species; it is from the roof of the 8-foot coal in the coal-measures of Durie, Fife, and was given me by Mr. Kirkby, of Leven. It has a certain resemblance to the shell from Wakefield, but it is unlike every other example in having that portion of the shell above the oblique ridge evenly gibbous. There are, however, in this place obscure radiating lines, and the posterior end, not quite perfect, was hardly so truncate as in the type; but on comparing this figure with that of fig. 19, Pl. XV, a close resemblance will be noted.

There is a fairly typical specimen of this species in the Geological Survey Collection from Burrs, near Bury, Lancs, labelled *Sanguinolites*, sp., in Mr. Salter's handwriting. It is in quite a different matrix from the specimens labelled *Anthracomya sanguinolaris* (MS.), and referred to at p. 35 of the 'Memoir of Geol. Surv.,' "The Geology of the Country round Bolton-le-Moors," which I identify as *A. Williamsoni*.

I noted a specimen in the museum at Dresden from the Grube Hannibal, near Bochum, which I believe to belong to this species. In Great Britain *Anthracomya Wardi* is rare, even in the beds in which it does occur, and has a very limited horizontal distribution.

7. Anthracomya pumila, *Salter*. Plate XVI, figs. 2, 3, and 40.

Anthracomya pumila, *Salter*. 'Iron Ores of South Wales,' p. 230, pl. ii, fig. 10, 1861.

Non — — *Hind*. Quart. Journ. Geol. Soc., vol. xlix, p. 269, pl. x, figs. 17, 19, 28, 29, 1893.

— carinata (pars), *Hind*. Ibid., p. 273, pl. x, figs. 16, 16*a*.

Specific Characters.—The shell is transversely oblong, only slightly convex. The hinge-line and ventral margins are almost straight and nearly parallel. The umbones are small with depressed non-contiguous apices, situated within the anterior third of the hinge-line; the lunule is narrow and elongate. The anterior end is short, and somewhat pointed at its anterior superior angle. The posterior end is bluntly rounded or truncate. There is an obtuse diagonal ridge which rises in the umbones, and passes backwards and downwards to the posterior inferior angle of the shell, above which the shell is compressed so as to become slightly concave and expanded upwards into the posterior hinge-line.

The *Interior* is not exposed in any of the specimens from South Wales.

The Exterior.—The surface is covered with striæ and lines of growth, more marked and rugose at the ventral border; periostracum wrinkled.

Dimensions.—Fig. 2, Pl. XVI, measures—

Antero-posteriorly	17 mm.
Dorso-ventrally	8 mm.
From side to side	5 mm.

Locality.—Mine over Three-quarter coal, No. 6 pit, Victoria, South Wales Coal-field, and at Merthyr Tydvil.

Observations.—This species is at present only known from the bed above the Three-quarter coal of South Wales, which was the locality whence the original specimens described by Mr. Salter were obtained. It is just possible that the specimens I am able to figure, by the courtesy of the authorities of the Cardiff Museum, are the originals, as they have in their possession the collection of the late Mr. Adams, which Mr. Salter states contained his type.

This species differs materially from any of the forms in North Staffordshire that have come to my knowledge, being much more compressed than *A. Williamsoni* and much more elongate than *A. minima*, the latter being the typical shell in the Knowles ironstone, which Mr. Salter gave as the horizon for *A. pumila*.

In my paper on the "Affinities of *Anthracoptera* and *Anthracomya*," 'Quart. Journ. Geol. Soc.,' vol. xlix, p. 269, I doubtfully referred some young specimens of *A. Williamsoni* and *A. pulchra* to this species, but from a study of the series in the Cardiff Museum I have arrived at the conclusion that these forms are quite

distinct. *A. pumila* may be distinguished from *A. pulchra* by the flattened compressed form, and the absence of the well-marked escutcheon posteriorly.

In my paper of 1893, *op. sup. cit.*, I erroneously referred a specimen from the Strickland Collection in the Woodwardian Museum, Pl. XVI, fig. 40, to a new genus erected on two specimens which I now recognise as distinct. The one specimen agrees closely with many other forms from the South Wales Coal-field.

8. ANTHRACOMYA SUBCENTRALIS, *Salter*, 1861. Plate XVI, figs. 1 and 4—9; Plate XVII, figs. 3—5; Plate XIX, figs. 21, 21 *a*.

ANTHRACOMYA SUBCENTRALIS, *Salter*. 'The Iron Ores of South Wales,' p. 231, pl. ii, fig. 9 *a*, 1861.
MYACITES FABÆFORMIS, *Kinahan*. Geology of Ireland, pl. iv, figs. 4 *a*, 4 *b*, 1878.
ANTHRACOMYA SUBCENTRALIS, *Hind*. Quart. Journ. Geol. Soc., vol. xlix, p. 268, pl. x, figs. 30, 30 *a*, 1893.

Specific Characters.—The shell is transversely oblong, markedly convex. The anterior end is rounded, tumid, somewhat prominent and deep dorso-ventrally. The inferior border is almost straight, the posterior inferior angle bluntly rounded. The posterior border is bluntly rounded, and the posterior superior angle is well marked and slightly obtuse. The hinge-line is straight and almost parallel to the inferior border. The umbones are very obtuse and tumid, hardly marked off from the general gibbosity of the shell; the apices are acute, incurved, and pointing slightly forwards. They are situated about the junction of the anterior and middle thirds of the length of the shell. The lunule is well marked. The valves are evenly swollen in an oblique direction from the umbones to the posterior inferior angle, above which the shell is much compressed into the hinge-line, so that it is often slightly concave. The ligament is external, very short, and not much elevated, and there is a long narrow groove on each side of it representing the escutcheon.

The *Interior* is unknown.

The Exterior.—The surface is almost smooth, but is marked towards the ventral border by well-defined lines of growth. The periostracum is wrinkled.

Dimensions.—Fig. 21, Pl. XIX, in the Museum of the Geological Survey, Jermyn Street, measures—

Antero-posteriorly	25 mm.
Dorso-ventrally	13 mm.
From side to side	10 mm.

Localities.—South Wales: mine over the Three-quarters Coal, No. 6 Pit, Victoria. The roof of the Hard-mine Coal, Mossfield Colliery, Longton. The

Cockshead Ironstone, Hulme Colliery, Longton. *Ireland.*—The roof of the Three-foot Coal, Bilboa, Queen's County.

Observations.—This species appears to be a rare form even in South Wales. It is quite distinct from *A. pumila*, from which its convex form at once distinguishes it. The position of the umbones even in Mr. Salter's original figure hardly merits the epithet subcentral. I have, however, shown that the position of the umbones on the hinge-line is a varying factor in other species of this genus, and therefore do not regard such a character as of any value in specific determination. I figure, by the kind permission of the Director-General, three specimens, Pl. XVII, figs. 3, 4, 5, from the Three-foot Coal of Bilboa, Queen's County, Ireland, which had been named *Myacites fabæformis* (Kinahan). These shells have all the characters of Salter's *A. subcentralis*, to which I have now referred them. The hollow character of the compressed upper and posterior portion of the shell is well shown in all the examples. The blunt truncate posterior end is very characteristic. The specimens, Pl. XVI, figs. 5—8, from the Cockshead Ironstone are much crushed and distorted, figs. 7 and 8 having lost the anterior end by these means, but the hollow posterior slope and peculiarly truncate posterior are well marked.

The best specimens of this species that I know are in the Collection of the Geological Survey, one from South Wales, the other from Bilboa, Queen's County, Pl. XVII, fig. 3. It is curious that the palæontologists in Ireland never seem to have adopted Mr. Salter's genus for their shells, for, as far as I can trace, the genus *Anthracomya* has never been credited to the Irish Coal-measures until now.

In the 'Geological Survey Memoir,' "The Iron Ores of Great Britain," part 4, p. 294, Mr. Salter mentions the occurrence of *A. subcentralis* with *A. pumila* in the Knowles shale of the North Staffordshire Coal-field, but I know of no specimen from these beds which can be in any way referred to this species. As far as is at present known, the forms *A. Phillipsii* and *A. minuta* are the only species of this genus which occur at this horizon. I am unable to trace the original specimens on which these lists were founded, either in Messrs. Ward and Garner's collections or in the collection of the Geological Survey, so that it is impossible to discover on what grounds the references were made.

9. Anthracomya obovata, *Hind.* Plate XVI, fig. 41.

Anthracomya obovata, *Hind.* Quart. Journ. Geol. Soc., vol. xlix, 1893, p. 270, pl. x, figs. 22, 22 *a*.

Specific Characters.—Shell obovate, inequivalve, the left valve being more convex. Anterior end almost obsolete, tumid, bluntly pointed. Posterior end

expanded, flattened backward and downward, and into the hinge-line, which is much raised. The hinge-line is straight, about three-quarters the length of the shell. Umbones prominent, blunt, separate, situated one-seventh the distance of the hinge-line from the anterior end. The inferior border is curved rapidly downward from the anterior end, then becomes bluntly and gently rounded into the posterior border, which extends in the form of a regular semicircular curve from the inferior to the superior angle. A blunt swelling, rapidly flattened on its posterior side, extends from the umbo to a point in the inferior border anterior to its posterior limit. There is no appreciable byssal sulcus, but there appears to have been a byssal notch at the junction of the anterior and middle thirds of the inferior border.

Interior smooth, with folds of growth; anterior and posterior adductor scars as in other species. Ligament external. Lunule distinct.

Measurement.—Antero-posterior measurement 30 mm.; greatest dorso-ventral (at posterior end) 17 mm.; from side to side 7 mm.

Locality.—Roof of the Hard-mine Coal, Adderley Green, Longton.

Observations.—I have found only one specimen of this very distinct and characteristic form. It looks much like some forms of *Anthracoptera*, from which it can be distinguished by its umbones and hinge-line. It has occurred to me that this may well be an example of mimicry, the more so because the form *Naiadites elongata* resembles very closely certain forms of *Anthracomya*; in fact, it is only on very close examination of the umbones and hinge-lines that these forms can be correctly referred to their proper genera.

The fact that I have only been able to obtain one good example of this species throws some doubt as to its reality, and it is quite possible that the shell may be a deformity or even a hybrid. The expanded posterior end and anterior position of the umbones indicate an approach towards the form of *A. senex*, but there is no pronounced angularity of the diagonal ridge.

10. ANTHRACOMYA SENEX, *Salter*. Plate XV, figs. 21—28.

ANTHRACOMYA SENEX, *Salter*. "Iron Ores of South Wales," Mem. of the Geol. Surv., 1861, p. 230, pl. ii, fig. 10.

— — *Hind*. Quart. Journ. Geol. Soc., 1893, pl. x, p. 270, figs. 20, 20 *a*, 21.

Specific Characters.—Shell transversely cuneiform, oblique, moderately convex. The anterior end is small, ellipsoidal, and blunt, and the narrowest part of the shell. Its border is regularly curved, and passes gradually into the inferior border, which is directed downwards and backwards, being slightly sinuated about its centre. The posterior border is obliquely truncate from above downwards and

backwards, making an obtuse angle above with the extremity of the hinge-line, and below it forms a blunted acute angle with the inferior border, the posterior inferior angle being extended far behind the rest of the shell. The hinge-line is straight, elevated posteriorly, inclined to the inferior border, so that if each were produced forwards they would meet at a very acute angle. It is much shorter than the greatest antero-posterior diameter of the shell. The umbones are obtuse, swollen, slightly raised above the hinge-line, and not contiguous, and are situated anteriorly; they are not conspicuously marked off from the rest of the shell in front, but posteriorly have the upper border continuous with a well-marked oblique, more or less angulated ridge, which passes downwards and backwards to a point somewhat anterior to the posterior inferior angle, becoming gradually less marked as it traverses the shell. Anterior to the oblique ridge is a well-marked oblique sulcus, which becomes shallower but broader as it approaches the inferior margin, which is sinuated at this point. This sulcus can be traced nearly up to the umbones themselves. Posterior to and above the oblique ridge the shell is rapidly constricted, so as to become concave on the posterior slope, above which the valves are compressed and expanded upwards.

Interior.—Specimens showing the muscle-scars and hinge-line have not yet been obtained.

Exterior.—The surface of the shell is covered with very fine lines of growth, and in the absence of periostracum appears almost smooth.

The periostracum is thick and very much wrinkled, especially posteriorly, but with no definite pattern. The external ligament is almost as long as the posterior hinge-margin and comparatively large.

Dimensions.—The type specimen, Pl. XV, fig. 21, measures—

Antero-posteriorly.	Greatest dorso-ventrally.	Laterally.
25 mm.	14 mm.	15 mm. (but valves are somewhat open).
Pl. XV, fig. 26, 29 mm.	15 mm.	12 mm.

Localities.—Darranpins, Ebbw Vale. Sychffos: Cwm Aman, South Wales. Roof of the Hard-mine Coal, and the Cockshead Ironstone, Adderley Green, North Staffordshire.

Observations.—By the kind permission of Sir Archibald Geikie, Director-General of the Geological Survey, I have been able to study and figure the specimen on which Mr. Salter founded this species which is placed in the Collection of the Geological Survey at Jermyn Street, Pl. XV, fig. 21. The shell has the valves partially open, and the inferior and posterior borders are incomplete at the extreme edge. It is a gibbose shell with very strongly marked oblique keel, and the periostracum much wrinkled, but not in quite such a regular fashion as depicted in Mr. Salter's figure. If the right valve be examined it is found that

the V-shaped arrangement of the wrinkles is at right angles to that which obtains in the left valve, and that the condition is purely accidental. Mr. Salter says of this shell (*loc. supra cit.*), " The general appearance is that of an ordinary convex *Modiola;* but the epidermis, deeply wrinkled V-fashion over the posterior slope, shows its true affinity." He goes on to say, relying on this *quasi*-affinity to Myadæ which he allowed to overbalance the evidence afforded by shape, " We cannot get at the interior, but there is not much doubt that there is a pallial sinus, and there were probably long siphonal tubes covered by a thick epidermis, the animal burrowing in the mud as most of the Myadæ do "—a condition which subsequent investigation has shown to be absent. It was only under the head of *A. senex* that any observations are made with regard to the generic affinity of Anthracomya, and it is probable that the wrinkled periostracum of *A. senex* was the chief factor in referring this genus to the Myadæ. I have on this account gone into the details given by Mr. Salter, and have quoted fully from his remarks. *A. senex* is a rare shell, and I have only met with one other specimen from South Wales, also in the collection of the Geological Survey, but have obtained a few from the Hard-mine and Cockshead Ironstone of North Staffordshire, but in these beds it appears to be very rare. This species is easily distinguished from all others by its oblique wedge-shaped gibbose form, and by the raised hinge-line posteriorly and strongly marked diagonal keel.

11. Anthracomya Valenciensis, *R. Etheridge, jun.*, nov. sp. Plate XVI, figs. 44—48.

Specific Characters.—Shell small, pisiform, tumid. The anterior end is small, regularly swollen, and has a convex border. The posterior end is expanded and compressed with a bluntly convex border. The inferior border is almost straight, passing with a gradual curve in front and behind into the anterior and posterior borders. The hinge-line is straight, elevated posteriorly, somewhat shorter than the greatest antero-posterior measurement of the shell. The umbones are small and inconspicuous, slightly raised above the hinge-line, and non-contiguous. The shell is evenly swollen in an oblique direction, the swelling being soon lost on the surface of the shell.

Interior.—Not known.

Exterior.—The surface is covered with fine lines and striæ of growth which run parallel to the anterior inferior and posterior borders. The periostracum is wrinkled.

Dimensions.—Fig. 46, Pl. XVI, measures—

Antero-posteriorly	8 mm.
Dorso-ventrally (behind) . . .	5 mm.
From side to side	4 mm.

Locality.—Dalmeny railway-cutting, near Wester, Dalmeny. Lower Carboniferous of Scotland.

Observations.—This little species has the characteristic shape of the genus. A set of fourteen specimens are in the Geological Survey Collection of Edinburgh, labelled *A. Valenciensis*, MS., R. Etheridge, jun., all from the locality stated above. This species appears to be the smallest and, at the same time, the earliest member of the genus known in Carboniferous times. I know of no other species which can be mistaken for it, as it is much more regularly globular than *A. minima*, unless it turns out to be the perfect form of *A. lævis*, var. *Scotica*, which is only known in a much-compressed condition.

12. Anthracomya pulchra, sp. nov., *Hind.* Plate XV, figs. 29—49.

Anthracomya pumila, pars, *Hind.* Quart. Journ. Geol. Soc., vol. xlix, 1893, p. 269, pl. x, figs. 28 and 29.

Specific Characters.—Shell transversely oblong, convex, at times almost cylindrical. The anterior end is compressed, and has its border almost circularly curved, the posterior superior angle not being prominent. The upper border of the anterior end is much below the level of the umbones. The inferior border is straight or slightly concave, joining the anterior border by an abrupt curve, while posteriorly it forms a more or less obtuse angle with the obliquely truncate posterior border, so that the posterior inferior angle is well marked and somewhat acute, and this point is the most posterior portion of the shell The hinge-line is straight, deviating very slightly from parallelism with the ventral edge. The umbones are obtuse, gibbose, almost contiguous, and raised above the hinge-line. They are situated anteriorly at a point distant from the anterior end equal to about one-fifth the length of the hinge-line. The umbones are excavated in front by a well-marked lunule, and posteriorly there is a well-marked escutcheon or groove on each side of the external ligament, which is erect, and small and short. The posterior or greater portion of the shell is convexly swollen in an oblique direction from the umbo to the posterior inferior angle. The compression anterior to the ridge, characteristic of this genus, is only seen at the lower edge of the shell, about the centre, as an almost obsolete broad sulcus. Above the swelling the shell is

rapidly compressed into the hinge-line, so that this portion of the shell is slightly concave, and at times is crossed by obsolete radiating lines.

Interior.—Normal; hinge like that of *A. modiolaris*, the details being very minute.

Exterior.—The surface is almost smooth, but there are very fine striæ and lines of growth. Periostracum wrinkled.

Dimensions.—A full-grown example from the Burnwood Ironstone, Golden Hill, measures—

Antero-posteriorly	23 mm.
Dorso-ventrally	11 mm.
From side to side	9 mm.

Localities.—The Burnwood or Little-Mine Ironstone of North Staffordshire, Fenton, Golden Hill, Pitts Hill, and New Chapel.

Observations.—At Golden Hill (North-Staffordshire Coal-field), the Burnwood or Little-Mine Ironstone, as it is called in the Longton district of the same coal-field, consists of a finely laminated ironstone above, containing *A. Adamsii*; but its lower part is much more homogeneous and not at all well stratified, and in this part of the bed *A. pulchra* is found with *Naiadites carinata*. At Fenton, however, the species does not seem to occur, though *A. Adamsii* is very common, and is nearly always found in a perfect state. I believe that this is the shell which Mr. Salter identified as *A. pumila* in his remarks on the palæontology of the North Staffordshire Coal-field (*op. supra cit.*), but on comparing it with the South Wales specimens the difference is very apparent; *A. pulchra* is much more convex. The oblique ridge is less angular than in *A. pumila*, Salter, or in *A. Williamsoni*, Brown, and the posterior end not expanded to so great an extent as in the Welsh shells. I figured two crushed specimens of this shell as *A. pumila* (*op. supra cit.*), the characteristic features being obliterated. I have never met with this species from any other seam or coal-field. It is very abundant and in a splendid state of preservation in all stages of growth in the bed stated.

I have figured a series, Pl. XV, figs. 29—49, to show the change of shape resulting from growth. The absence of any marked expansion of the posterior end in the young is very apparent, room for the viscera being obtained by a much greater convexity of the shell posteriorly than obtains in most of the species of the genus, but later on in life the typical shape is always present. I have not figured any specimen showing the hinge. The details are very small, and it is difficult to get specimens altogether free from matrix; but from fragments I have seen I believe the hinge-apparatus to be identical with that of *A. modiolaris*. No casts have as yet been obtained.

13. Anthracomya minima, *Ludwig*. Plate XVI, figs. 21, 22, 24—34.

? Modiola minuta, *Brown*. Fossil Conch., 1849, pl. lxxii, fig. 29.
Non — minima, *Brown*. Ibid., pl. lxxii, fig. 28.
Anodonta minima, *Ludwig*. Palæontographica, Bd. viii, 1859–60, p. 36, pl. v, fig. 14.
Modiola Carlotta, *Römer*. Geol. und Palæontol. von Oberschlesien, 1870, p. 76, foot-note.
— sp., *Volpersdorf*. Zeitschrift der Deutsch. Geol., vol. xvii, 1865, p. 276, Taf. vi, fig. 6.
— (or Anthracomya), undescribed form, *Salter*. 'Iron Ores of South Wales,' Geol. Surv. Mem., 1861, p. 233, pl. ii, figs. 1, 2.
Anthracomya minima, *Hind*. Quart. Journ. Geol. Soc., vol. xlix, 1893, p. 272, pl. ix, figs. 11, 12.

Specific Characters.—Shell small, ovately and obliquely triangular. The anterior end is very short and tumid, with a rounded border. The posterior part forms the greater portion of the shell; it is expanded and compressed, especially upwards. The posterior border is rapidly and obliquely sloped from above downwards and backwards in its upper portion, but at the lower angle is truncate and bluntly rounded, this angle being the most produced part of the shell. The inferior border is almost straight, but has a slight sinuosity. The hinge-line is straight, equal to half the extreme antero-posterior diameter of the shell in length, and if the upper and lower borders were produced forwards they would meet at an acute angle.

The umbones are small, swollen, not contiguous, situated very far forwards. From the umbones there passes downwards and backwards an oblique swelling, which extends almost to the posterior inferior angle ; anterior to this swelling is a well-marked sulcus, which becomes broader and shallower as it approaches the inferior margin.

Interior.—As far as can be seen in fragments the arrangement of muscular impressions is normal.

The external surface is almost smooth, marked with many very fine concentric lines and folds of growth, which are crowded together in front, but become separated as they pass backwards, following the general shape of the shell, and when they reach the oblique swelling are gradually curved upwards, so that they pass in a forward direction to the superior border.

Dimensions.—Pl. XVI, fig. 27, measures—

Antero-posteriorly	8 mm.
Dorso-ventrally	4 mm.
From side to side	2 mm.

Distribution.—Knowles Ironstone, Longton railway-cutting, south of Kidsgrove, in North Staffordshire. Middle Coal-measures. Prestolee, near Manchester. Black Band, Blaina, South Wales. Wylam Colliery, Northumberland. Scotland: Possil; Langton Burn, Dunse; Blackadder Water, Dunse.

Observations.—When I gave the name *A. minima* to this shell in 1893 I was unaware that the species had been named or described before. By a lucky coincidence I was fortunate enough to hit on the same specific name as that given by the earliest observer, R. Ludwig. It was the examination of his type specimens at Dresden which convinced me of the identity of his shells, though they were crushed, with the British forms. Unfortunately, too, his figures are not good. At that time Professor Geinitz showed me some specimens labelled *Modiola Carlotta*, Römer, which I could not distinguish from *Anthracomya minima*. I have therefore placed Römer's name as a synonym. Römer thought his shell had been previously described by Volpersdorf, who however, only gave it the generic name of Modiola.

Salter figures some small shells from the South Wales Coal-field, of whose generic affinity he evidently did not feel quite sure, as he calls them Modiola or Anthracomya. Judging from figures only, I think it probable that two of his specimens (figs. 1 and 2, not 3) may be referred to *A. minima*.

The general form of *A. minima* closely resembles that of *A. Phillipsii*, but it is much smaller; and owing to the fact that the latter shell nearly always occurs crushed, it is next to impossible to make out accurately many of its characters. The two forms were very gregarious in habit, and are found in large numbers in certain beds, but as far as I know not together; other species and genera are conspicuously absent, with the possible exception to be noted below. Still there is nothing antagonistic to the view that one was only a dwarfed form of the other.

There often occurs both in Staffordshire and Lancashire, in a bed with *A. minima*, a form to which I gave the name *Anthracomya carinata*, and it would appear on comparing it with a typical specimen of the former to be quite distinct; but a series of intermediate forms occur which completely connect the two. I have, therefore, now placed *A. carinata* as a variety of *A. minima*. There is a resemblance also between our shell and the forms called on the Continent *Unio carbonarius*, Bronn, and *Unio Goldfussianus*, de Koninck. It is very difficult to form any conclusions as to what shells are represented by these names, owing to the disappearance of all the types, and the inaccuracy of authors, to which Professor Geinitz drew attention in a paper in 'Neues Jahrbuch' for 1864, p. 651. In the 'Petrefacta Germanica,' p. 181, pl. cxxxi, fig. 20, Goldfuss gives a figure of *Unio uniformis*, Sowerby, which, as de Koninck pointed out in his remarks on *Cardinia ovalis* in his 'Animaux fossiles du bassin Carbonifère de la Belge,' p. 74, is totally distinct from Sowerby's shell, and he

proposed the name *Goldfussiana* in its place; Sowerby's original *Unio uniformis* being an Oolite shell from Felmersham, Bedfordshire, and Goldfuss's *Unio uniformis* being totally different in shape, size, and occurring in the Carboniferous beds of the neighbourhood of Kusel. *Unio carbonarius*, the *Mytulites carbonarius* of Boué, figured by Bronn and Römer in 'Lethæa Geognostica,' Theil ii, p. 416, certainly belongs to the genus Anthracomya, and I believe will be found to be the same species as that figured by Goldfuss as *Unio uniformis*.

The figures of *Unio carbonarius*, Goldfuss, and *Cardinia carbonaria*, de Koninck, differ much from that of *U. carbonarius*, Bronn and Römer, to whose type, however, they both refer their specimens. All three authors also refer their specimens to *Tellinites carbonarius*, Schlotheim; but this specimen is said to come from Häring in the Tyrol, a locality where, although coal is present, the beds are, I am told by Professor Geinitz, of Tertiary age. Neither Goldfuss nor de Koninck says anything about their shell having an expanded end or oblique swelling (both present in Bronn's form), so that it must be concluded that the *Unio carbonarius*, Goldfuss, and *Cardinia carbonaria*, de Koninck, differ from *Unio carbonarius*, Bronn, and that the specific name *carbonarius*, having been applied by Schlotheim to a Tertiary shell, must be dropped. *Unio uniformis*, Goldfuss, and *Cardinia Goldfussiana*, de Koninck, are probably of the same species as Bronn and Römer's *U. carbonarius*. *Anthracomya minima* is much more oblique and less transverse than *Anthracomya Goldfussiana*, and has the oblique ridge and sulcus more developed, and the posterior end more expanded. It may be noted that the German shell is very thin, and unless well cleared from the matrix the thin expanded upper part of the posterior end may not be exposed, and the specimen will have the external appearance of a Carbonicola, for which, I have noted, it has been often mistaken. The lines of growth, though, are distinctly characteristic of Anthracomya rather than of Carbonicola.

It is difficult to obtain specimens of *A. minima* free from the matrix, but by calcination Mr. C. Roeder has managed to procure some fairly perfect examples, though of course much shrunken in size. The ironstone contains also fragments of Lepidodendron and other vegetable remains.

Larger specimens of a shell, Pl. XVI, figs. 21 and 22, are in the collection of the Geological Survey of Scotland, from near Dunse, which only differ from the English examples in size, and which I have therefore referred to this species.

13*. ANTHRACOMYA MINIMA, var. CARINATA. Plate XVI, figs. 35—39.

Non ANTHRACOMYA CARINATA (pars), *Hind.* Quart. Journ. Geol. Soc., vol. xlix, 1893, p. 273, pl. x, figs. 16, 16*a*.

General Characters.—Very much produced transversely, anterior end very small and almost obsolete, bluntly rounded, sloping rapidly into the inferior border, which is so slightly convex as to appear almost straight. The posterior part is produced, forming about seven-eighths of the shell, with a strong oblique ridge passing downwards and backwards to the inferior border at the junction of the third and posterior fourth of its extent, when it becomes lost on the surface of the shell. Anterior to the ridge the shell is sinuated and flattened, and very rapidly compressed into the lower border. Above the ridge the shell is also rapidly compressed into the superior border. The posterior border is curved elliptically.

The hinge-line is straight, equalling about three-fourths of the length of the shell in measurement. The umbones are situated very anteriorly, tumid, and small.

The exterior is covered with fine striæ and lines of growth, which, starting from the anterior end, become curved upwards as they reach the oblique swelling, and are reflected up to the superior border. Periostracum thick and wrinkled.

Interior not seen.

Dimensions.—Fig. 39, Pl. XVI, measures—

Antero-posteriorly	22 mm.
Dorso-ventrally (at posterior end) . .	8 mm.
Laterally	7 mm.

Localities.—From an ironstone band on the Middle Coal-measures of Lancashire at Prestolee. The Knowles Ironstone bands, North Staffordshire Coal-field.

Remarks.—The specimen I first described I now find to have greater affinity with *A. pumila*, Salter; and, moreover, it comes from the locality of Salter's type. I had neither seen the series of shells from the South Wales Coal-field in the Cardiff Museum, nor the intermediate forms which connect *A. carinata* with *A. minima*. I have now found them in the beds both in Lancashire and North Staffordshire which contain this shell, but owing to the differences in form and size, and the comparative rarity of this variety, I have still retained the name *carinata*, but as a varietal form of *A. minima*. The chief difference which marks off this variety is in the very rapid and excessive growth of the posterior end, and the consequent throwing into greater relief the oblique ridge, which, instead of being directed towards the inferior posterior angle, is left behind some distance along the lower border.

I noted in my first description that this shell somewhat resembled *Anthracomya lanceolata*, Pl. XV, fig. 11. It may be that this form stands in the same relation to *A. Williamsoni* that the variety *A. carinata* does to *A. minima;* and I am the more inclined to think that this is the case, as I meet with an elongate form of *Anthracomya pulchra*, Pl. XV, fig. 29, and an elongate form of *Anthracomya Adamsii*, Pl. XII, fig. 9, each occurring and only occurring in the same beds as the normal variety, though this may not be true of *A. Williamsoni* and the form *A. lanceolata*, as the actual horizon at which the latter occurs is at present uncertain.

14. Anthracomya Phillipsii. Plate XVI, figs. 10—16.

Unio Phillipsii, *Williamson.* Phil. Mag., vol. ix, p. 351, 1836.
Non — linguiformis, *Phillips.* Murchison's Sil. Syst., p. 88, 1839.
Modiola, sp., *Binney.* Mem. Lit. Phil. Soc. Manchester, 2nd ser., vol. xii, p. 221, note, 1855.
Anthracomya Phillipsii, *Huxley and Etheridge.* Cat. Foss. Mus. Pract. Geol., pp. 157—160, 1865.
— — *T. Rupert Jones.* Geol. Mag., vol. vii, p. 217, pl. ix, figs. 3 and 18, 1870.
— — *R. Etheridge, jun.* Ibid., ser. 2, vol. iv, pp. 243, 244, pl. xii, figs. 6 and 7, 1877.
— — *Hind.* Quart. Journ. Geol. Soc., vol. xlix, 1893, p. 262, pl. ix, figs. 6, 6*a*, 7, 8; pl. x, fig. 27.

Specific Characters.—Shell transversely obliquely oval, modioliform, elongated in a diagonal direction. The anterior end is small, its margin rounded. The posterior end is compressed, expanded downwards and backwards, while above it is rapidly compressed into the upper border, which is elevated posteriorly. The hinge-line is straight, about one-half the length of the diagonal of the shell. The ventral margin is convex, passing with a gentle curve into the anterior end, and becoming straight shortly before it reaches the posterior end. The umbones are anterior and directed forwards, very blunt and gibbose, the beaks themselves inconspicuous. The shell itself is fairly tumid, and the valves are gibbose. There is no sign of an oblique constriction anterior to the gibbosity, which is itself very gradual in its form. Behind the gibbosity the valves are so rapidly compressed as to become hollow on the posterior slope.

Interior.—As far as can be seen in Pl. XVI, fig. 14, which is a cast, the interior is normal, but the anterior adductor scars are not seen, owing to damage to the specimen.

Exterior.—The surface is covered by fine and coarse striæ and lines of growth, which have the general arrangement which obtains in this genus. Periostracum thick and wrinkled.

Dimensions.—The type specimen, Pl. XVI, fig. 10, measures—

	Greatest diagonal . . .	20 mm.
	Greatest dorso-ventral . . .	12 mm.
Pl. XVI, fig. 14—	Greatest diagonal . . .	20 mm.
	Greatest dorso-ventral . . .	11 mm.
	Lateral	8 mm.

Localities.—Blackband ironstone and shales of the North Staffordshire Coal-field, as far down as the Basseymine and the Gubbin ironstone. The Knowles ironstone series, North Staffordshire. The Upper Coal-measures of Ardwick, Lancashire; Slade Lane and Bradford, near Manchester. Blackband, Blaina, South Wales. Coal-pit, Heath, and black shale, Kingswood deep pit; Bristol Coal-field; Speedwell pit, Gloucester; Trafalgar pit, Cinderford, Forest of Dean.

Observations.—The original type of this species was named by Dr. W. C. Williamson, who obtained his specimen from the Spirorbis-limestone shale of Pendlebury. He described it as "delicate, broad, and wide proportionally to its length," and says his specimen resembled that vague shell *U. nuciformis*, of Hibbert, of which all trace has been lost. He states, too, that in this bed the shell is always compressed. I am able to figure this shell in Pl. XVI, fig. 10, by the kind permission of the authorities of the Manchester Museum, Owens College. Phillips, in a letter quoted by Murchison in his 'Silurian System,' p. 88, describes four different shells (Unios) as occurring in these beds. *One* — smooth, tumid, with prominent beaks, but with very distinct lines of growth, and rather short, straight hinge-lines, looks like a young *Modiola; a second form*, with nearly elliptical hinge-line, deviating considerably from parallelism with the front ends in a prominent angle; "lines of growth strong, shell very thin, beaks slightly prominent. Mr. Williamson has inaccurately referred this shell to *Unio nuciformis*. It occurs in the red beds above the limestones, in the black bass and in the underlying Coal-measures."

A "third species, which I named *Unio rugulosus*, is of obliquely expanded or semi-elliptical form, the hinge-line forming the diameter [I suppose he means when both valves are lying open, flattened out, connected by the hinge]. Surface concentrically marked with broken undulations, often showing radiations on the posterior slopes; shell exceedingly thin. Unionidæ of the same species occur in the bed of mottled marls above the [Spirorbis] limestones, in the black bass or shale above the main limestone, and in the shale beneath all the calcareous bands."

A difficulty at once arises as to which shell Phillips considered identical with Williamson's *Unio Phillipsii*. Four forms altogether are described in the letter to Sir Roderick Murchison quoted above; the first "a shell so very like a young *Modiola*," and three forms referred to *Unio*. In the remark on the first of these

Unios, which was not mentioned by name, Phillips says, "Williamson has inaccurately referred this shell to *Unio nuciformis*" [of Hibbert]. The second Unio is named *Unio linguiformis* = *Unio Phillipsii*, Williamson, although no grounds are given for this apparently arbitrary change of name, in spite of a description, though meagre, having been published, part of which I have quoted above. It is to be noted that Mr. R. Etheridge, in his redescription of this species (*op. supra cit.*), adds "without description" to his reference to Williamson's original publication: quoting him, I fell into the same error in my former paper.

Williamson only describes one shell, but mentions later in his paper remains which had been mistaken for fish scales, measuring about a quarter of an inch across. But it is the shell which he refers to *Unio nuciformis* and calls *Unio Phillipsii*. Moreover this species cannot be said to have a "hinge-line (which) deviates very little from parallelism to the front lines of growth." Indeed, Phillips's first Unio shell appears from the description to correspond better with Williamson's form. Neither Professor Rupert Jones nor Mr. R. Etheridge, jun., noticed this curious mistake of Professor Phillips, both authors giving *Unio linguiformis* as a synonym of *Anthracomya Phillipsii*.

The original specimen being that of a shell crushed flat, it is difficult to judge what exactly would be the form of uncrushed examples. I have referred fairly perfect shells from the horizon of the Knowles ironstone to this species, Pl. XVI, figs. 11—13, one of which (fig. 11) is a cast, and the exact outline of the shell cannot be seen on account of imperfections of the extreme anterior portion and the posterior border. The others (figs. 12 and 13) would, I think, if crushed flat, exhibit a similar form to those of *A. Phillipsii*, which occur in such numbers in the higher beds.

If I am correct in my reference, *A. Phillipsii* was a fairly tumid shell, so gently tumid that the diagonal ridge so characteristic of the genus is not apparent; and this view is supported by an observation by Mr. E. W. Binney, that in the uncrushed state the shell closely resembles a Modiola. This is so, speaking broadly, but the position and shape of the umbones are characteristically different from that which obtains in Modiola. I have recently obtained both crushed and uncrushed specimens of this species from the Speedwell pit, Gloucestershire. In these shells the oblique ridge is more acute, and not so gradually gibbose as in the forms from the Knowles Ironstone, Fenton.

The shell seems to occur at several horizons in the Bristol district, judging from the matrix in which they occur, but I am unable to give the exact beds. This is, I believe, a new discovery (the shells were collected by Mr. Stock, of Bristol), and an interesting one, as molluscan remains are very rare indeed in this coal-field.

In crushed examples it is often very hard to distinguish between *Anthracomya*

and *Naiadites* (*Anthracoptera*); and, indeed, in perfect examples there is a striking resemblance. I rely principally on the position and shape of the umbones, which are almost terminal and pointed forwards in *Naiadites*.

This shell occurs in very large numbers closely packed and all crushed flat in the black bands and ironstones of the Upper Coal-measures of North Staffordshire, and here to the exclusion of all other molluscs.

Professor T. Rupert Jones, F.R.S., who appears to have been the first to figure this shell ("On some Bivalve Entomostraca from the Coal-measures of South Wales," *loc. supra cit.*), draws attention to the resemblance in shape between some of the Carboniferous Estheriæ and the genus Anthracomya.

15. ANTHRACOMYA LÆVIS, var. SCOTICA, *Dawson*. Plate XVI, figs. 17—20, 42, 43.

? UNIO RUGULOSUS, *Phillips*. Murchison's Sil. Syst., p. 88, 1839.
? CARDINIA FREYSTENII,[1] *Geinitz*. Die Versteinerungen de Steinkohlenformation in Sachsen, pl. xxxv, fig. 7 *a*, *a*, 1855.
NAIADITES LÆVIS, *Dawson*. Acadian Geol., 1st edit., 1860; 2nd edit., p. 204, fig. 44, 1868.
ANTHRACOMYA (NAIADITES) LÆVIS, *Salter*. Quart. Journ. Geol. Soc., vol. xix, p. 79, fig. 2, 1863.
? ANODONTA OBSTIPA, *Ludwig*. Palæontographica, Bd. x, p. 22, pl. iii, figs. 2, 2 *a—f*, 1863.
ANTHRACOMYA SCOTICA, *R. Etheridge, jun.* Geol. Mag., dec. 2, vol. iv, p. 244, pl. xii, fig. 8, 1877.
— LÆVIS, *Hind*. Quart. Journ. Geol. Soc., vol. xlix, p. 264, pl. x, fig. 31, 1893.
— — — Ibid., vol. l, p. 441, pl. xx, fig. 12, 1894.

Specific Characters.—Shell obliquely broad-ovate. Dorso-ventral and antero-posterior diameters almost equal, hitherto only known as flat and compressed. The anterior end is short and pointed, its border is rapidly produced downwards and forwards in a curve to join the lower border, which is with the lower part of the posterior border almost circular. The posterior end is flattened and produced ventrally. The border is rounded below, but almost straight above, and obliquely truncate from above downwards. The hinge-line is straight, not quite as long as the transverse diameter of the shell; posteriorly the hinge-line forms an obtuse angle with the posterior border. The umbones are anterior, not terminal.

The *interior* is unknown.

[1] Professor Geinitz writes me that he now considers this shell to be an *Estheria*. *See* 'Sitz. Isis,' 1879, No. 1, p. 10.

The *exterior* is marked with exceedingly close, fine, microscopic, thread-like striæ, which are closely crowded in front, but become parallel to the margin, and terminate in the upper border. Obscure radiating lines are sometimes present.

Dimensions.—Pl. XVI, fig. 19, measures—

Antero-posteriorly	10 mm.
Dorso-ventrally	9 mm.

Localities.—Scotland: Limehouse Water, near Mid Calder; Straiton oil shales near Burdiehouse; Shale, Inchkeith Island; Quarry, east of Binn Hill, Burnt Island, Fife; Middleton Pit, Uphall, Edinburghshire, all in the Cement Stone group near the horizon of the Burdiehouse Limestone; Wardie Shales, Water of Leith, Kates Mill, near Edinburgh at a lower horizon. England: Trafalgar Pit, Cinderford, Forest of Dean. Roof of Cannel Coal, Wigan. Spirorbis Limestone, Ardwick.

Observations.—Mr. Robert Etheridge, jun., who was the first to describe the shell now under consideration, drew attention to the close resemblance between it and *Anthracomya lævis* of Dawson. He states that "I was for some time quite at a loss how to distinguish between them; however, *A. scotica* is larger than the Nova-Scotian *Naiadites lævis*. Judging from Dr. Dawson's figure, the concentric striæ are also more numerous, finer, and closer; the posterior end appears to be more obliquely truncate, and the beaks are more anterior." These distinctions seem to me to be due to a large extent to a difference in size, and hardly to be characters of specific value. I have had the opportunity of examining specimens of the Nova Scotian form, and those that I have seen are only half the size of the Scotch examples, and are, as Mr. Etheridge states, somewhat more oblique, and the striæ are finer and closer. From a study of young and adult forms of this genus the growth always appears to be more rapid towards the posterior end, and the tendency is for shells as they increase in size to become less oblique. It would be natural, too, to suppose that in the smaller examples the lines of growth would be finer and closer. I have, therefore, considered it best to retain Sir W. J. Dawson's name of *lævis* for this shell, adding the name *scotica* as denoting a large variety. Mr. Salter (*op. cit.*, p. 80) identifies Dawson's shell with one found in the Upper Coal-measures of the neighbourhood of Manchester. This may perhaps be the form named *Unio rugulosus* of Phillips, the description of which seems to agree very well with *A. lævis*. Should this be the case, the name *rugulosus*, dating 1839, must supersede all others. The description of *U. rugulosus* is "of obliquely expanded or semi-elliptical form. The hinge-line forming the diameter [of both valves]. Surface concentrically marked with broken undulations, often showing radiations on the posterior slopes. Shell exceedingly thin." ('Sil. Syst.,' p. 88.)

Mr. Etheridge, jun., also queries whether Hibbert's *Unio nuciformis* may not

be the uncrushed form of his *A. scotica*. On this point it is impossible to give an opinion, as the original shell has completely disappeared.

Mr. Etheridge, jun., drew attention to the close resemblance between Ludwig's *Anodonta obstipa* and his species of *A. scotica*. This is very apparently so, but it is unsafe in the case of crushed and flattened shells to be too dogmatic. Ludwig shows that his specimen possessed a microscopically reticulated surface which, while it agrees with Dr. John Young's prismatic cellular structure of Naiadites and other Mytiliform shells, also partakes of the character which Prof. T. R. Rupert Jones considers ('Geol. Mag.,' 1870, p. 217) "very unusual in molluscs, but common in Estheria."

Prof. Rupert Jones, however, later pointed out that Dr. John Young had demonstrated to him that shells in the genera Anthracoptera [Naiadites], Posidonomya, Pinna, Pteronites, Myalina, Aviculopecten, &c., possess a reticular punctate surface ('Trans. Geol. Soc.,' Glasgow, 1890, p. 86), and he affirms the molluscan character of some shells previously considered to be crustacean. Judging from the figures and description, *Cardinia Freystenii* of Prof. Geinitz ('Die Versteinerungen der Steinkohlen-Formation in Sachsen,' 1855, p. 2, pl. xxxv, fig. 7 *a*, A) might be mistaken for *A. lævis*, var. *scotica*, but it is somewhat larger, the measurements given being 13 mm. long by 11 mm. high. I can distinguish no other difference between this shell and the types of Mr. R. Etheridge, jun.; but Professor Geinitz writes me that he now considers this shell to be an Estheria, and if this be the case of course there is no question of nomenclature involved; but should this shell have been wrongly referred to Estheria, the specific name *Freystenii* is anterior to others.

I have figured, Pl. XVI, fig. 23, an example of *A. lævis* from the South Joggins Coal-field of Nova Scotia, that it may be compared with the British forms.

Fig. 20, Pl. XVI, shows an unusual character in the sinuosity of the posterior border just below the posterior superior angle, a condition more typical of the genus Naiadites. It is impossible, owing to the crushed state of the specimen, to pronounce with absolute certainty on the genus, but the general facies of the shell is that of *Anthracomya lævis*, var. *scotica*, and not of Naiadites.

A. lævis, var. *scotica*, approaches *A. Phillipsii* more closely than other forms; this may be, however, because both forms are met with crushed flat, and we are really almost in ignorance as to the contours of the shells. Both species were very gregarious, and though they existed for a long period, yet they had only a limited horizontal distribution.

Family MYTILIDÆ.

Genus Naiadites, *Dawson*, 1860.

G. F. Myles, 'Memorabilia Saxoniæ Subterraniæ,' p. 39, pl. xxvi, fig. 10, 1720.

Synonyms:

Modiolus, Fleming, 1825.
Mytilus, Fleming, 1828.
Modiola, Sowerby, 1840.[1]
Mytilus, Sowerby, 1840.
Avicula, Sowerby, 1840.
[No name], R. Garner, 1844.
Modiola, Brown, 1849.
Avicula, Brown, 1849.
Mytilus, de Ryckholt, 1852.
Modiola, Lea, 1853.
Dreissenia, Ludwig, 1859–61.
Myalina, McChesney, 1860.
— Meek and Worthen, 1860.
Naiadites (pars), Dawson, 1860.
Myalina, Salter, 1861.
Anthracomya? Salter, 1861.
Anthracoptera, Salter, 1862.
Anthracomya, Hull, 1873.
Myalina, R. Etheridge, jun., 1875.
Anthracoptera, R. Etheridge, jun., 1875.
— Ward, 1875.
Myalina, Kirkby, 1880.
Conocardium, Achepol, 1880–83.
Dreissenia, Achepol, 1880–83.
Mytilus, Achepol, 1880–83.
Myalina, Barrois, 1882.
Anthracoptera, Hind, 1893.
Naiadites, Hind, 1894.

Generic Description.—Shell modioliform, obliquely triangular, very unequilateral, close all round; inequivalve, the left valve being the more tumid, the right valve flattened. Both valves notched for the byssus, the left one being so cut to a greater extent. The anterior end is oblique, forming a small lobe anterior to the umbonal ridge. There is always present a more or less defined oblique ridge passing from the umbones backwards and downwards, most marked in the left valve. The hinge-line is straight. The hinge-plate is striated, and possesses in front an obscure cardinal tooth, that of the left valve being anterior, and that in the right posterior. The umbones are almost terminal, and generally pointed forwards. The shell is strong and even massive anteriorly, becoming gradually thinner posteriorly, till at the extreme end it may be very fragile. The surface is furnished with flat concentric lamellæ, and lines of growth. Periostracum thick and wrinkled. Anteriorly the lines of growth are close and crowded, but they separate as they pass backwards and become distinct; and when they reach the oblique ridge they become reflected rapidly upwards towards the hinge-line. I have seen no trace of internal or external ligament, but the place of

[1] *See* foot-note, p. 83.

a ligament was taken by the fibro-cartilage which was attached to the striations on the hinge-plate.

Interior.—The pallial line is represented by a series of small pits and is not sinuated. The posterior adductor scar is almost circular, large, and situated near the posterior border. The anterior adductor scar is small, pit-like, and is situated within the beak somewhat anterior to the umbo. There are two accessory pit-like scars for the pedal and anterior byssal muscle; one is umbonal, and the other is midway between the umbo and the anterior adductor scar. The scars for the byssal muscles are almost obsolete.

Observations.—In the very first work that I can find on the subject of fossil bivalves from the Coal-measures, by G. F. Myles, dated 1720 (*op. supra cit.*), figures are given of the genus Naiadites, but unfortunately no name was given to them (*vide antea*, p. 12). Since that time the genus has passed through many changes in nomenclature, and it has been a matter of some little difficulty to decide as to the priority of the different claims. Except in one case, authors have always referred the shells of this genus to one of two families, the Aviculidæ and the Mytilidæ; the exception being in the case of Achepol, who referred specimens to Conocardium, a genus which has really no characters in common with Naiadites. The reference to Avicula was made only by two authors; one of whom was J. de Carle Sowerby, and the other Captain Brown, who simply repeated Sowerby's figure and description.

Sowerby curiously enough described four species of this genus under three different generic names in the same publication ('Geol. Coalbrookdale'); namely, Modiola, Mytilus, and two under Avicula, all four figures being good and characteristic. The genus Naiadites can easily be separated from Avicula, as it possesses no ears nor cartilage-pit, and the valves, though unequal, are not greatly so. The general shape, too, is very dissimilar.

To Modiola and Mytilus the genus Naiadites seems to be very closely related, but it has certain distinctive characters which separate it from both of them. From Modiola, Naiadites is distinguished by the possession of a striated hinge-plate, the absence of an internal ligament, and by being less transversely produced. From Mytilus Naiadites is separated by the non-terminal umbones, the absence of internal ligament, and the striated hinge-plate. The possession of this latter character points to the fact that Naiadites is intermediate between the Aviculidæ and the Mytilidæ.

Ludwig referred his specimens of Naiadites to Dreissenia, to which genus there is a very close external resemblance, both in shape and ornament; but Dreissenia possesses an internal septum in the beaks, which I have never seen to occur in Naiadites; and in Dreissenia the posterior adductor muscle is riband-like and

flat, and is inserted into the shell close to the upper border, whereas it is thick and obovate in Naiadites.

Many authors have referred specimens of this genus to Myalina, de Koninck; but this author states in the original description of this genus, "À l'intérieur et immédiatement au-dessous de ceux-ci (les crochets), une petite lame septiforme, semblable à celle qu'lon observe dans certaines espèces de Mytilus." As I have mentioned above, if Myalina has this septum, Naiadites is at once distinguished by its absence, although Myalina is said to possess a striated hinge-plate. The shells from the Permian of Durham called *Myalina squamosa* and *M. septifera* undoubtedly have this septum, and possess the other characters of Myalina enumerated by the author of that name.

In the 'Geological Magazine,' 1893, vol. x, dec. 3, p. 514, I published a note on the *Myalina crassa* of Fleming, showing that this shell could not be separated from the genus Anthracoptera (Naiadites) by any one character. M. Barrois ('Recherches sur les terrains anciens des Asturias et de la Galice,' p. 334) remarks on this close resemblance between Myalina, de Koninck, and Anthracoptera, Salter, and thinks it impossible to distinguish between them; he therefore describes his species as *Myalina carinata* and *M. triangularis*, thus making Myalina synonymous with Anthracoptera; but he did not notice that the lamelliform myophore of Myalina was absent in his specimens. De Koninck also says his shell is "equivalve," a character which does not agree with the genus under description. This fact is referred to by M'Coy, 'Brit. Pal. Foss.,' p. 491, note, who quotes and agrees with Professor King, who had stated that the genus Myalina was inequivalve.

American palæontologists have always named their Mytiliform Carboniferous shells Myalina, and indeed prior to his note on these shells in the 'Geol. Surv. Memoir, Geol. Country around Wigan,' 2nd edit., 1862, p. 371, giving the diagnosis of his new genus Anthracoptera, Mr. Salter ('Iron Ores of South Wales,' p. 229) had said, "They have been referred to Avicula, but are probably Myalina;" and he figures the *Avicula modiolaris* of Sowerby as Anthracomya in pl. ii, fig. 13.

Mr. Salter's diagnosis of the genus Anthracoptera is as follows:—"They have neither the unequal valves of Avicula nor the striated hinge-plate of Myalina, nor indeed any hinge-plate at all. There is a very obscure tooth in the anterior part of the hinge, but only a thickened margin to the hinge-line, and no lateral tooth at all," &c.

This statement I showed to be incorrect ('Quart. Journ. Geol. Soc.,' vol. xlix, p. 250, pl. vii, figs. 1, 1 *a*, 1 *b*, 2, 2 *a*), for there is no doubt as to what shells Mr. Salter referred to, and his Anthracoptera is now known to possess a well-marked striated hinge-plate, unequal valves, and an obscure anterior tooth (Pl. XVII,

figs. 8—10, 12—15); but at that time I kept Mr. Salter's name. On the publication of this paper Sir W. J. Dawson wrote to me that he considered his name Naiadites, published in the Supplementary Chapter, 'Acadian Geology,' 1860, p. 43, had prior claim to Mr. Salter's Anthracoptera, and that he had had some correspondence with him on the subject; so much so that when Salter was describing some remains from the South Joggins Coal-field, 'Quart. Journ. Geol. Soc.,' vol. xix, p. 80, 1863, he figured some specimens which W. J. Dawson had sent him as Anthracomya (Naiadites) and Anthracoptera (Naiadites). In the next edition of the 'Acadian Geology,' 1868, p. 204, we find W. J. Dawson refers his shells to Naiadites (Anthracomya), and Naiadites (Anthracoptera).

Under the term Naiadites were described and figured seven shells, the first only really belonging to Mr. Salter's genus, the majority belonging to Anthracomya, and one only to Carbonicola. Under these circumstances Sir W. J. Dawson and I agreed to substitute his name of Naiadites for Mr. Salter's Anthracomya, and we placed before the Geological Society a joint note to this effect; but it was pointed out that the name should be retained for the first shell in the list rather than for the majority. This shell happened to be *Naiadites carbonaria*, and consequently I altered my note to suit this view, and replaced Mr. Salter's genus of Anthracoptera of 1862 by Sir W. J. Dawson's Naiadites of 1860. The question then arose as to whether de Koninck's Myalina might not even supersede Naiadites, as from my discovery of the striated hinge-plate, the great point on which Mr. Salter relied for separate diagnosis was removed; but there still remained the fact that de Koninck affirmed a rostral plate or myophore in his description, which was, however, conspicuously absent in his figures, and more markedly so in the illustrations in pl. xxix of his later work, 'Faune du Calcaire carbonifère de la Belgique,' 1885. In the text he states, p. 168, "J. W. Salter a créé en 1863 pour quelques espèces mytiliformes provenant des assises inférieures de terrain houillier, le genre Anthracoptera; celui-ci a aussi beaucoup d'analogie avec le genre Myalina, mais sa charnière est égalment mince et linéaire et son ligament est externe." This is rather a curious remark, as a few lines above he had stated, "Bord cardinal epais, plat, avec plusieurs rainures longitudinales de cartilage."

It is quite possible that all de Koninck's species of Myalina differ from those of Naiadites, as the former are all stated to be from the Calcaire carbonifère of Visé, where they are associated with a typical marine fauna. M'Coy ('British Palæozoic Fossils,' p. 492) says in his description of Myalina there is "a triangular septum in the cavity of each beak, parallel with the plane of the lateral margins (leaving deep slits under the beaks of the casts)," but he makes no mention of specimens of this genus from British Carboniferous rocks. I have therefore adopted the name Naiadites (Dawson) for the Mytiliform shells of the Coal-measures for a twofold reason. First, because they do not possess myophorial septa; and second,

because they do not occur with a typically marine fauna as a rule,—the one possible exception being the *Naiadites crassa* of the Beith and Pitlessie beds, and I am in doubt as to the real conditions under which these deposits were laid down.

At Pitlessie the shells are accompanied by Stigmaria and other vegetable remains, scales of Megalichthys and Spirorbis, together with Aviculopecten, Encrinites, and corals. The shells are in a much disturbed state, and very few are whole or possess the valves in contact; and with such a mixed fauna and flora, the bed may well have been the result of a wash; but, as I have remarked, very many shells exhibit fractures repaired during life. It is not at all impossible that *Naiadites crassa* was of marine habitat, and that the dwarfing of the other members of the genus may be due to a change of condition of environment. At Beith, the other habitat of this shell, it is found in a bed resting on coal associated with fish remains. Here the shell is in a somewhat better preserved state, the valves often being in contact; the evidence shows that at this place the shell was truly marine; certainly its extremely local occurrence is very marked. The three pit-like muscular scars within the anterior part of the shell are characteristic of the genus. It is difficult to be accurately certain as to the several muscles which each represents. The anterior two pits are much larger than the posterior, and possibly represent a bifid anterior adductor, while the posterior pit represents the attachment of the long anterior byssal muscular bundle. M'Coy ('British Palæozoic Fossils,' p. 492), speaking of Myalina, says, "The small impression over the large anterior adductor I find (in the recent Mytili with rostral plates) is the scar of the insertion of the adductor from the opposite valve, instead of retractors of the foot, as commonly supposed, the larger impression being the scar of origin thereof." My own dissections of *Dreissenia polymorpha* hardly bear out this, but Professor M'Coy may be referring to *Mytilus bilocularis* (*Septifer*, Recluz), with which I am not acquainted.

Mr. Salter mentions the fact of this genus, Anthracoptera, possessing in front an obscure tooth in the hinge; it is curious, if he had good enough specimens to ascertain this fact, that he did not notice the striated hinge-plate. The tooth is very obscure in the smaller species, but even in these it is to be made out in well-preserved examples. It is to be seen in the specimens figured on Pl. XVII, fig. 15; Pl. XIX, figs. 1—7.

The striated hinge-plates seem to have been in contact in the smaller forms to such an extent that nothing whatever of them was visible when the valves were together, but in the larger shells of *Naiadites crassa* this hinge-plate is at such an angle that the valves could only have been in contact along the lower border, leaving an elongate pit, triangular in section, which lodged the cartilage; and it is, of course, in the larger species a mechanical necessity that the hinge-plate

should have been bevelled at the expense of this upper surface, in order that the valves might open.

The genus Naiadites was gregarious in its habit, and attached itself by the byssus to pieces of wood or other shells; masses are often found together.

There is in the British Museum (Nat. Hist.), Cromwell Road,[1] an interesting slab from the shale above the Kinderscout grit of Rabchester, Lancashire, on which is shown a piece of wood surrounded on three sides by masses of Naiadites two and three deep, lying in many cases with their inferior borders towards the wood, as if attached to it by the byssus. This habit and the possession of a byssus precludes the idea that these shells were burrowers; and an additional piece of evidence is the frequent presence of Spirorbis even on those shells which have the periostracum preserved. It is only a reasonable inference, too, to suppose that the shells of Carbonicola and Anthracomya, which nearly always occur with Naiadites, and under similar conditions as to the presence of Spirorbis, were not of a burrowing habit.

Dr. John Young, of the Hunterian Museum, Glasgow, has made out that the genus Naiadites possesses, in common with the Aviculidæ, Pinnæ, and others, an outer layer of prismatic cellular structure. He read a note[2] of this discovery before the Glasgow Geological Society on January 13th, 1880. He says, "So far as I have examined my Carboniferous Lamellibranchs, I find that this prismatic structure is confined to shells belonging to the Aviculidæ . . . and the Mytilidæ."

I figure on Pl. XVII, fig. 11, a portion of a shell of Naiadites from the Coal-measures of Knightswood, N.W. of Glasgow, which shows this structure.

R. Ludwig had as long ago as 1863 pointed out the similar structure in a shell which he calls *Anodonta obstipa* ('Palæontographica,' Bd. x, pl. iii, figs. 2 *h*, *f*, ×100) from the left bank of the Uswa, near Nischni, Parogi, Perm. This shell has the appearance of an Anthracomya, in which genus, Dr. Young says, he has not been able as yet to demonstrate prismatic structure.

1. Naiadites modiolaris, *Sowerby*, 1836–40. Plate XVII, figs. 8—10, 12—30.

Avicula modiolaris, *Sowerby*. Trans. Geol. Soc., ser. 2, vol. v, pt. 3, pl. xxxix, fig. 18, read 1836, pub. 1840.
No name. *R. Garner*. Nat. Hist. of County of Stafford, pl. E, figs. 21, 22, 1844.
Avicula modiolaris, *Brown*. Fossil Conch., p. 162, pl. lxi **, figs. 23, 24, 1849.
Modiola funata, *Brown*. Ibid., p. 172, pl. lxxi, figs. 12, 13.
— subtruncata, *Brown*. Ibid., p. 173, pl. lxxii, figs. 15, 16.

[1] 'Geol. Mag.,' dec. 3, vol. x, 1894, p. 540.

[2] "Notes on some Carboniferous Lamellibranchs, their Mode of Occurrence and Observed Shell-structure," 'Trans. Geol. Soc. Glas.,' vol. vi, 1890, p. 223.

MYTILUS WESEMAELIANUS, *de Ryckholt*. Mélanges paléontologiques; Mém. Couronn. Acad. Roy. Belg., vol. xxiv, 1852, p. 140, pl. viii, figs. 11, 12.

MODIOLA WYOMINGENSIS, *Lea*. Journ. Acad. Nat. Sci. Philad., new ser., vol. ii, pt. 3, p. 203, pl. xx, fig. 1 *a*, 1853.

DREISSENIA LACINIOSA, *R. Ludwig*. Palæontographica, vol. viii, p. 38, pl. v, figs. 15, 19, 1859.

— INFLATA, *R. Ludwig*. Ibid., vol. viii, p. 190, pl. lxxi, figs. 8—10, 1861.

— DILATATA (pars), *R. Ludwig*. Ibid., p. 189, pl. lxxi, figs. 5—7.

MYALINA MODIOLARIS, *Salter*. Geol. Surv. Mem., 'Iron Ores of South Wales,' p. 228, pl. ii, fig. 14, 1861.

ANTHRACOMYA? MODIOLARIS, *Salter*. Ibid., p. 230, pl. ii, fig. 14.

— — *Ward*. Trans. North Staff. Inst. Min. and Mech. Engin., vol. x, 1890, p. 125, pl. i, fig. 13, 1890.

ANTHRACOPTERA MODIOLARIS, *Hind*. Quart. Journ. Geol. Soc., vol. xlix, p. 251, vol. vii, figs. 1, 1 *a*, 1 *b*, 3—6, 1893.

Specific Characters.—Shell obliquely elongated, compressed posteriorly. The hinge-line is straight, nearly or quite as long as the greatest length of the shell.

The anterior part of the shell is represented by a small gibbose lobe, which projects forwards with a rounded border, which becomes concave below, and is pierced by the byssus. The posterior part forms the greater portion of the shell; it is produced downwards and backwards, expanded, and gradually compressed into the margin. The posterior border is bluntly curved, but it may be straight or even emarginate, and meets the hinge-line at an angle which is either greater than or equal to a right angle. The junction of the inferior and posterior borders is bluntly curved. The umbones are anterior, not quite terminal, and on reaching the hinge-line are curved forwards and inwards, not contiguous, slightly elevated above the hinge-line. An acute and prominently swollen ridge, flatter in young specimens, passes obliquely backwards and downwards, and, while preserving its character in the anterior two-thirds, rapidly becomes lost in the lower and posterior third. Anterior to this oblique ridge the shell is markedly constricted, often becoming slightly concave. The ridge is bent forwards in front, and is parallel to the hinge-line. It is much more pronounced in the left valve. The right valve is much flattened.

Interior.—The anterior muscle-scars are three in number, pit-like; the anterior markedly the largest, and situated within the umbo; the next is situated just below the horizontal part of the ridge (in casts), while the posterior scar is on the right exactly at the point where its direction becomes changed downward. The posterior scar is large and obovate, situated close to the posterior superior angle of the shell. Faint traces of the attachment of byssal muscles are occasionally seen near the upper border. Two or three slight

diverging grooves are seen on the posterior slope, which apparently rise from the upper part of the keel, and are seen as ridges in casts. The hinge-plate is striated (in some specimens with as many as ten striæ) in the anterior two-thirds; it then becomes narrowed as it passes backwards, and finally at about half the length of the hinge-line disappears, and the flattened and thinned upper border of the opposite valve comes in contact. The lowermost striæ are the most prolonged, the hinge-plate being thickest at the anterior end. In front above the striæ of the hinge-plate is seen the inner surface of the umbo, which overlaps slightly inwards in young and unworn specimens. These striæ appear to represent the bevelled edges of the plates of which the shell is composed, having been deposited in succession from the mantle, and the innermost being the largest. They can be traced downwards for a short extent into the anterior border, but soon become lost, and have entirely disappeared at the byssal notch.

Exterior.—The surface is ornamented with striæ and lines of growth; the striæ may almost be said to be obsoletely imbricated. These lines of growth arise at the apex of the shell, and are densely crowded. They pass downwards parallel to the edge of the shell with a slight divergence until they reach the oblique ridge, when they become separated by wider and regular intervals, and, reflected rapidly at a right angle, they pass across the posterior part of the shell to the superior border. Periostracum thick and wrinkled. Shell thick relatively to its size. Its greatest thickness is

Dimensions.—Pl. XVII, fig. 17:

Greatest antero-posterior . . .	32 mm.
Greatest dorso-ventral . . .	21 mm.
Greatest thickness	14 mm.

Localities.—England:—The roof of the Hard-mine, Banbury, Holly Lane, and Moss on Easling Coals, and Knowles or Winghar and Burnwood Ironstones of North Staffordshire. White flats; Coalbrookdale. Thirty feet below the Arley Mine, Rochdale. Stubb's Mine, Ashton-under-Lyme. Above the Shale Coal and Stanley Main, Wakefield. Above the Brockwell Seam, Wigglesworth. Codnor Park, Derbyshire. South Wales:—Darren Pins. Scotland:—Annandale; Kilwinning; Shotts; Shettleston; Splint Coal, near Glasgow; Clyde Pits.

Observations.—This species was first described under the generic name of Avicula by Sowerby (*op. supra cit.*). Captain Brown, in the 'Fossil Conchology,' copied Sowerby's descriptions, adding only a few words, but gave entirely different figures. He then figured and described under the names *Modiola fimata* and *M. subtruncata* forms which are so much like the original drawings of Sowerby that I have given them as synonyms. This generic reference was, however, much more correct than the original one of Avicula.

I have very little doubt that the *Mytilus Wesemælianus* of de Ryckholt from

the Coal Shale of Mons should be referred to the species under discussion. His description is "Coquille un peu triangular, anguleuse, très-inéquilateral, rétrécie et émousée en arrière, dilatée et arondie en avant; . . . . côté cardinal droit; région du ligament comprimée; région palléale renflée," which corresponds very well with that given above. Isaac Lea gives a typical figure of *Naiadites modiolaris* under the name *Modiola Wyomingensis* (*op. supra cit.*) from the Coal-measures in the neighbourhood of Wilkesbarre. His description is "Testâ lævi triangulari infernè compresso-alatâ; umbonibus elevatis acutè angulatis;" and he remarks, "This is a broad, flat species." Scales of Palæoniscus occurred with the shells.

Ludwig appears to have divided this species into three, to each of which he gave names, apparently unaware that Sowerby and Brown had already done the same thing between them, and to an equal extent. I have had the good fortune in this case to see the original specimens now in the Museum at Dresden, and find that the fossils so beautifully drawn are embedded to a large extent in the matrix and are very imperfect. I was unable to see on what grounds *Dreissenia laciniosa* was divided from *Dreissenia dilatata*. The former is said to be sharply triangular "am unteren Ende dreizipfelige," while *D. dilatata* is "unten stumpf zugerundete;" but in many cases the shells are so compressed and distorted as to render it unsafe to erect species upon them. Fig. 10, pl. xxi, *op. cit.*, the drawing of *D. inflata*, is a pure invention, the specimen being not a fossil at all, but a clay-ironstone concretion. It is noteworthy of Mr. Salter's great uncertainty of the real affinities of some of the Coal-measure shells that in the Geological Survey Memoir 'The Iron Ores of South Wales,' on p. 228, he gave "*Myalina modiolaris* (*Avicula*, 'G. Tr.,' pl. xxxix, fig. 18), pl. ii, fig. 14," and on p. 230, "*A.* ? sp. (*Avicula modiolaris*, Sow.), pl. ii, fig. 14, aberrant form;" thus referring the figure of one shell to two different genera. The "diagram of the general shape and characters" of Anthracoptera, given with his original description by Mr. Salter, 'Memoirs Geological Survey, Great Britain,' "Geology of the Country around Wigan," 2nd edit., Appendix, p. 38, 1862, might have been drawn from a typical specimen of *N. modiolaris;* it possesses the emarginate posterior border which would become trifid if the shell were flattened, and would appear like Ludwig's *Dreissenia laciniosa*. This condition is very rare, being naturally absent in casts, and, owing to the extreme fragility of the shell at the posterior border, is rarely preserved except in specimens crushed flat in the shale. The presence or absence, then, of this emarginate posterior border is not of specific value, being present or absent according to the state of preservation of the fossil. In the same volume and on the same page from which I have just quoted Mr. Salter describes a new shell as *Anthracoptera ? Browniana*, with which he states *Avicula tenua*, referred to by Mr. Binney in the 'Manchester Geol. Trans.,' vol. i, p. 161, pl. v, fig. 23, and described by Brown in 'Foss. Conch.,' p. 161, pl. lxviii, fig. 9, is

synonymous. Of this shell he gives the following description :—"It is exceedingly thin, almost papery in texture, and so little can be seen of the hinge or muscular impressions that I do not feel sure it belongs to the genus here for the first time proposed." This speaks for itself, and a comparison of Captain Brown's with Mr. Salter's half-real, half-ideal figures will render the species *Anthracoptera Browniana* of Salter exceedingly problematical. There exists, as far as I can see, no excuse for the change of Captain Brown's specific name of *tenuis*, which had not been appropriated in Mr. Salter's new genus. I suspect that Captain Brown's shell will probably turn out to be Posidonia, which is very abundant in some beds of the Lancashire Coal-field. I would point out, too, that Captain Brown represented his specimens as perfect; but Mr. Salter, to transform the shell into his new genus, dotted in a hypothetical outline. In most museums and collections the name *Anthracoptera Browniana* was given to such flattened and crushed specimens as were too imperfect to identify with other forms. I have therefore seen no reason for retaining a name, in respect of which even the author himself seems to have had considerable doubt.

Mr. John Ward's determination of *Naiadites modiolaris* as *Anthracomya modiolaris* is evidently due to Mr. Salter's misleading statement quoted above, for the figure in the 'Iron-ores of South Wales' is referred to in support of his opinion.

Naiadites modiolaris is somewhat variable in shape, but always is more nearly a right-angled triangle than any of the other species of this genus. The hinge-line may be as long as, longer than, or even less than the greatest length of the shell; this may be due, as I have pointed out above, to the accidental non-preservation of this posterior edge of the shell; the variation also from the angle made by the junction of the posterior and superior borders to a blunt curve is probably due to the same cause, *i. e.* casts of the interior do not show the extreme length or accurate shape of the posterior end, for here the two valves came absolutely into contact.

2. Naiadites triangularis, *Sowerby*. Plate XVII, figs. 31—38.

Mytilus triangularis, *Sowerby*. Trans. Geol. Soc., ser. 2, vol. v, pt. 3, pl. xxxix, fig. 16, 1840.

— Toilliezianus, *de Ryckholt*. Mélanges Paléontologiques, p. 141, pl. viii, figs. 13, 14, 1852.

— ampelitæcola, *de Ryckholt*. Ibid., p. 143, pl. viii, fig. 17.

Myalina Swallovi, *McChesney*. New Sp. Palæozoic Fossils, p. 57, pl. ii, figs. 6, 6 *a*, 1860.

— — *Meek and Worthen*. Geol. of Illinois, Palæontology, vol. ii, p. 341, pl. xxvii, figs. 1 *a—d*, 1866.

? Myalina triangularis, *Barrois*. Recherches sur les terrains anciens des Asturies et de la Gallice, p. 336, pl. xvi, fig. 14, 1882.

Anthracoptera triangularis, *Hind*. Quart. Journ. Geol. Soc., vol. lxix, p. 253, pl. vii, figs. 7—9 *a*, 1893.

Specific Characters.—Shell mytiliform, compressed obliquely, obovate with a pointed anterior end, and the posterior wall, much flattened and produced obliquely downwards and backwards, comprising the greater part of the shell. The posterior border is regularly curved almost in a semicircle, and it passes imperceptibly into the upper and lower borders. The hinge-line is straight, equal in length to about one-third of the greatest length of the shell. At the posterior end of the hinge-line the superior border of the shell slopes downwards and backwards, passing gradually into the posterior border with a gentle curve. The inferior border is very oblique and nearly straight. The byssal notch is situated at the junction of the anterior and middle thirds. The umbones are not so tumid as in the preceding species, but similar in shape and direction. An oblique ridge passes obliquely downwards and backwards, but soon becomes lost on the surface of the shell.

Interior and external markings as in *Naiadites modiolaris*.

Dimensions.—Fig. 31, Pl. XVII, measures—

Greatest antero-posterior . . .	38 mm.
Greatest dorso-ventral (close to posterior end) .	21 mm.
Thickness	10 mm.

Localities.—England:—Roof of the Hard-mine Coal, North Staffordshire. Grains Ironstone, South Staffordshire. Crawstone, Coalbrookdale. Blue Vein, Ebbw Vale. Scotland:—Shotts.

Observations.—This shell only differs from *Naiadites modiolaris* in shape, and is distinguished by its flatter form and the shape of the posterior end; a greater amount of growth having taken place towards the posterior inferior extremity, with the result of making the hinge-line much shorter than the extreme length of the shell. It is very doubtful whether this condition should be regarded as of specific value, but I have retained the name for the present because it is quite easy to distinguish between the two forms, and typical young examples occur along with the adults. At the same time it is true that many specimens occur which it is difficult to determine, and a series might easily be figured connecting the forms *N. modiolaris* and *N. triangularis* on the one hand, and *N. triangularis* and *N. carinata* on the other. Sowerby's original figure was from an imperfect specimen, which I am unable to trace. This was incomplete at the posterior superior angle, and a hypothetical outline was dotted in. This specimen must have been juvenile, for its extreme antero-posterior measurement is only 18 mm.,

and the dorso-ventral measurement is only 8 mm., so that the shell is long compared to its depth.

The description given is meagre, being "Triangular, with a rounded front, rather flattened, keeled towards the beaks." It is therefore a question as to which adult forms should be referred to under this name. Judging from shape alone, *N. modiolaris* merits the term triangular, but the much greater comparative dorso-ventral measurements, and the fact that Sowerby's original figure of *Avicula modiolaris* is very typical of that form of the shell which possesses a hinge-line somewhat shorter than the length of the shell, make it impossible to consider that the more triangular forms of this shell should be referred to *N. triangularis*. Again, emphasis is laid upon the fact that the shell is rather flat, and the drawing agrees with this description, and this prevented me from referring the new species, what I named *Naiadites elongata* in 1883 (*op. infra cit.*), to Sowerby's shell. In *N. elongata* the hinge-line is long and the shell transverse, but it is very much swollen in its entire length (Pl. XVIII, fig. 31).

In young and medium-sized specimens of *N. triangularis* (Pl. XVII, fig. 38) it is comparatively easy to imagine that the whole of the superior border is hinge-line, as, owing to the very gradual slope of the posterior part of the shell, the line of the hinge and posterior edge of the shell appear to be continuous; but on careful inspection this is seen not to be so. The hinge-line is comparatively short and the posterior border begins to fall away at once. This is shown in Sowerby's drawing, 'Trans. Geol. Soc.,' ser. 2, vol. v, pl. xxxix, fig. 18, left-hand figure, and the dotted line is carried forwards past the point to the posterior extremity of the hinge, and a fictitious posterior end, in its upper part, depicted. In young shells the posterior end is more truncate and less rounded (Pl. XVII, figs. 36 and 38), and the anterior end more lobe-like and pronounced.

Mytilus Swallovi of McChesney, Meek and Worthen, is, I think, doubtless referable to *N. triangularis*. They figure a full-grown form not to be distinguished from the specimen I figure (Pl. XVII, fig. 36).

I think it probable that *M. Toilliezianus* and *M. ampelitæcola* of de Ryckholt should all be referred to *N. triangularis*, the two names being given to young forms having the anterior end lobe-like, as in Pl. XVII, fig. 36. The former is stated to have been obtained from the coal shales of Mons, the latter from "l'ampélite alumineux" near Liége.

The figure given by M. Barrois is not like the original; it is subquadrate in shape, and in no way transverse, resembling rather a young specimen of *N. quadrata*.

Naiadites triangularis is to be distinguished by its obliquely triangular, flattened form, short hinge-line, and gradually curved posterior end, and by the oblique ridge extending only a short distance across the shell.

3. Naiadites carinata, *Sowerby*, 1836–40. Plate XVIII, figs. 1—16.

Modiola carinata, *Sowerby*. Trans. Geol. Soc., ser. 2, vol. v, pt. 3, pl. xxxix, fig. 15, 1836–40.

No name. *R. Garner*. Nat. Hist. of the County of Stafford, pl. E, fig. 19.

Modiola carinata, *Brown*. Foss. Conch., p. 175, pl. lxi ***, figs. 19, 20, 1849.

Mytilus Omaliusiana, *de Ryckholt*. Mélanges Paléontologiques, p. 144, pl. viii, figs. 22, 23, 1850.

— Mariæ (divisus), *de Ryckholt*. Ibid., p. 142, pl. viii, figs. 15, 16.

Dreissenia Feldmani (pars), *Ludwig*. Palaeontographica, Bd. viii, p. 188, pl. lxxi, figs. 3, 4, 1859–60.

— dilatata (pars), *Ludwig*. Ibid., p. 189, pl. lxxi, figs. 5 and 6.

Myalina carinata, *Salter*. Geol. Surv. Mem., "Iron Ores of South Wales," p. 228, pl. ii, fig. 15, 1861.

Anthracomya carinata, *Hull*. Coalfields of Great Britain, 4th edit., facing p. 38, fig. 3, 1873 and 1881.

Myalina carinata, *Barrois*. Recherches sur les terrains anciens des Asturies et de la Gallice, p. 336, pl. xvi, figs. 12 *a*, *b*, 1882.

Anthracoptera carinata, *Ward*. Trans. North Staff. Inst. Min. and Mech. Engin., vol. x, p. 129, pl. i, fig. 9, 1890.

— — *Hind*. Quart. Journ. Geol. Soc., vol. xlix, p. 253, pl. vii, figs. 2, 2 *a*, 10, 10 *a*, 11, 12, 12 *a*, 1893.

— tumida (pars), *Hind*. Ibid., pl. vii, figs. 13, 13 *a*, 14.

Specific Characters.—Shell produced obliquely downwards, rhomboidal, and gibbose. The anterior lobe is comparatively larger than in other species. The anterior and posterior margins are almost parallel, the anterior being straight and slightly notched about its centre for the byssus, the posterior for the most part straight, but slightly convex below at the posterior inferior angle, and may be either straight or convex above, according as the angle formed by the junction of the superior and posterior borders is a right angle or greater than a right angle. The inferior margin is short and rounded, almost semicircular. The hinge-line is straight, about as long as any diameter of the shell parallel to it. The umbones are anterior, not quite terminal. They at first lie parallel to the hinge-line, but then become twisted outwards and are continuous with a sharp ridge which crowns a broad oblique gibbosity very much more pronounced in the left valve. This swelling and ridge pass downwards and backwards and become lost on the surface of the shell near the posterior inferior angle, the line of the ridge forming with the hinge-line an angle of 45° in most cases. The anterior part of the shell forms a small projecting lobe, and is swollen above, but becomes compressed obliquely parallel to and in front of the ridge. The posterior part of the shell is much compressed, especially above.

Interior.—The arrangement of muscle-scars, and the hinge-line, differ in no way from the descriptions given under *Naiadites modiolaris*, except that the posterior adductor scar is circular, and is situated just on the slope of the ridge about half-way down the shell.

Exterior.—The markings are precisely similar in character and arrangement to those which obtain in the preceding species.

Dimensions.—Pl. XVIII, fig. 1, measures—

Greatest anterior posterior diagonal	30 mm.
Length of hinge-line	14 mm.
Thickness	11 mm.

Localities.—England: Roof of the Hard-mine, Ten-foot, Holly Lane, Banbury and Moss seams; Knowles Ironstone, North Staffordshire; Grains Ironstone, and Queen's Cross, Dudley, South Staffordshire; Crawstone, Coalbrookdale, Doe Hill, and Butterley, Derbyshire; Stanley Main, Wakefield. Blue vein, and the Darrenpins, Sirrhowy and Cwm Ammon in South Wales. Scotland: The Middle Coal Measures of Shotts, Shelleston, and Kirkwood.

Observations.—Sowerby's original description of his *Modiola carinata* is:—"Obliquely elongated; valves boat-shaped, deep; anterior lobe small." This is somewhat vague, but the figure is typical, and it is to be noticed in looking at the list of synonyms that few authors have made use of any other specific name.

De Ryckholt does not seem to have been aware that anything had been published on coal-measure Lamellibranchs, and his original specimens seem to have disappeared; I could find no trace of them either at Brussels or Liége. *Mytilus divisus* of this author is figured as *Mytilus Mariæ*, a footnote in the letterpress pointing out this change. This shell is from the Carboniferous clay of Tournay, and is stated to be "un peu quadrilatère, renflée . . . côté anal élargi, se raccordant par des arcs de cercle obliques avec les côté cardinale et palléale; ces sont presque droits." This description is very characteristic of *Naiadites carinata*, and agrees so closely with it that there can be little or no doubt that both shells belong to the same species; but it is very questionable as to what may have been the shell called by de Ryckholt *Mytilus Omalinsianus*, which came from coal shale near Visé, and is said to have its "côté buccal coupé obliquement de bas en haut, côté cardinal arqué" (the figure shows it to be straight), and the shape of the shell is described as "un peu lancéolée . . . comprimée sur la region palléale, convexe partout ailleurs."

This species does vary in its shape and convexity, and a series of specimens can be obtained showing a gradual passage on the one side into *N. modiolaris* and *M. triangularis*. Indeed it would be perfectly justifiable to make them all into one species and give them their original names as varieties, seeing that they all seem to occur together, at any rate in the Hard-mine bed of North Staffordshire,

which is the source of hundreds of specimens which I have gathered and studied. I have not done this, wishing to avoid confusion and knowing that the names of these three forms have been in use for over half a century.

On looking over the originals of Ludwig's *Dreissenia dilatata* and *Dreissenia Feldmani*, I recognised some crushed forms which had I met with in England I should have referred to *N. carinata*, but it is most unsatisfactory to have to speak positively on crushed and imperfect specimens, and Ludwig's figures are utterly untrustworthy. At any rate there is no sufficient reason to establish new species of a genus which varies so much in shape as Naiadites on poor crushed specimens. Mr. Salter's figure in the 'Iron Ores of South Wales' is very good, and evidently similar to Sowerby's type in size and shape; the latter is, however, a little incomplete at the posterior superior angle. When I wrote my paper on the "Affinities of Anthracoptera" I had not been able to obtain access to Mr. Etheridge's type specimen of *Anthracoptera tumida*, and erroneously identified some very tumid examples of *N. carinata* with his species (*op. cit.*, pl. vii, figs. 13, 13 *a*, 14). These are to be distinguished by the marked constriction (byssal sinus) anterior to the oblique ridge, and by the oblique ridge appearing to more nearly bisect the shell, so that the anterior part, though not lobe-like, is large in proportion.

4. Naiadites quadrata (*Sowerby*). Plate XVIII, figs. 17—21, 23—25.

Avicula quadrata, *Sow.* Trans. Geol. Soc., ser. 2, vol. v, pt. 3, pl. xxxix, fig. 17, 1836–40.
— — *Brown.* Foss. Conch., p. 162, pl. lxi**, figs. 27, 28, 1849.
Modiola producta, *Brown.* Ibid., p. 173, pl. lxii, figs. 11, 12.
Myalina quadrata, *Salter.* Geol. Surv. Mem. of Gt. Britain, "Iron Ores of South Wales," p. 228, pl. ii, fig. 16, 1861.
? — subquadrata, *Shumard.* Palæontology Upper Missouri, p. 33.
? — meliniformis, *Meek and Worthen.* Palæontology of Illinois, vol. ii; Geological Survey of Illinois, p. 343, pl. xxvii, fig. 3, 1866.
Anthracoptera quadrata, *Hind.* Quart. Journ. Geol. Soc., vol. xlix, p. 254, pl. viii, figs. 1—4, 1893.

Specific Characters.—Shell compressed, produced downwards, quadrate or U-shaped, very slightly oblique. The anterior side is almost obsolete, and pointed forwards; the posterior expanded, often to a large extent, and flattened. The left valve is somewhat more convex than the right. The anterior margin is almost straight, and obliquely cut, there being about its centre, if anything somewhat

anterior to the middle point, a slight sinuosity marking the aperture for the byssus. The inferior border is narrow, being obliquely semicircular, and it passes into the anterior and posterior borders in front and behind without any angle, forming one general curvature. The posterior border is generally straight, and meets the posterior extremity of the hinge-line at an angle varying from rather less than 90° to 110°. The hinge-line is straight, as long as or slightly longer than the greatest diameter of the shell parallel to it. The umbones are small, inconspicuous, twisted forwards to be parallel to the hinge-line, not contiguous. From the umbones there proceeds a strongly-keeled oblique gibbosity which is directed downwards with a slight inclination backwards, and becomes expanded and lost on the surface after it has traversed about half the depth of the shell; this is less pronounced in the right valve. The posterior end is flattened and produced directly backwards.

Interior.—Owing to the anterior end being so little developed, as in *Naiadites modiolaris,* the three anterior muscle-scars are close together, and the posterior adductor does not seem to be relatively so close to the hinge-line. Hinge-plate thickened in front and striated.

Surface-markings as in the three previous species.

Dimensions.—Fig. 23, Pl. XVIII, gives the following details:

Dorso-ventral	32 mm.
Length of hinge-line	22 mm.
Thickness	13 mm.

Localities.—Roof of the Hard-mine, Ten-foot, and Banbury seams; Little-mine or Burnwood Ironstone Fenton; above the Woodhead Coal, Froghall, in North Staffordshire; Grains Ironstone, Oldbury, and Portway Hall, Dudley; White-flats and Pennystone, Coalbrookdale. Netherton, near Morpeth; Bunker's Hill, west of Rochdale, thirty feet below the Arley mine. South Wales: The Darrenpins. Scotland: Middle Coal-measures of Shotts.

Observations.—This form was considered by Sowerby to belong to Avicula along with *Naiadites modiolaris;* why, it is somewhat difficult to conceive. His original description was—"Quadrangular, convex, keeled; anterior lobe small, pointed; front rounded." The original specimen appears from the drawing to be incomplete at its posterior superior angle; but it has the oblique ridge directed almost downwards—what I regard as typical of this form. The word quadrangular is somewhat misleading, as the figure well shows the oneness of the curve of the inferior border with the anterior and posterior edges. The view in profile shows a thicker shell than I have met with in North Staffordshire.

Mr. Salter's figure from South Wales (*op. supra cit.*) is complete and very typical.

Captain Brown, in his 'Fossil Conchology,' copied Sowerby's figure and descrip-

tion, retaining the name Avicula, and this probably is the reason why he describes in the same volume a shell (*Modiola producta*) which from his figure I take to be the same as Sowerby's form. It is said to occur in coal shale at Wakefield, but no notice is given in the description of any definite shape or characteristics. The posterior end of Captain Brown's specimen was imperfect, so that it is impossible to give a dogmatic opinion as to the real nature of the shell. In my opinion it was either a large form of *N. carinata*, or more probably a specimen of *N. quadrata*.

With regard to the American specimens, I am judging from figures and descriptions only, for I have been unable to obtain access to forms from Missouri and Illinois. The figures and descriptions, however, show such a close connection with British forms that I have ventured to place *Myalina subquadrata* and *M. meliniformis* as doubtful synonyms of Sowerby's species *N. quadrata*.

This form is comparatively rare; it occurs on an average of only one to a hundred of the other species in the Hard-mine of North Staffordshire. The characteristic flattened U-shaped form with a much expanded posterior wing separate it from other species. The oblique ridge, too, is more nearly at a right angle to the hinge-line. It is connected with *N. modiolaris* on the one side and *Naiadites carinata* by a series of intermediate examples, forming with the three foregoing species one natural group which appears to be developing into four different distinct forms, characterised mainly by changes in the rate of growth of the shell at different points, the concomitant variations in anatomy depending on this.

5. Naiadites elongata, *Hind*, 1883. Plate XVIII, figs. 22, 26—35.

Naiadites elongata, *Hind*. Quart. Journ. Geol. Soc., vol. xlix, p. 256, pl. vii, figs. 15, 15 *a*, 16, 17, 1883.

Non — — *Dawson*. Acadian Geology, 1st edit., p. 43; 2nd edit., p. 202, fig. 43.

Specific Characters.—Shell tumid, modioliform, transversely elongated, only slightly equivalve. The anterior end is short and swollen, the posterior obliquely tumid below, flattened and compressed above so as to become concave between the hinge-line and the oblique gibbose keel, which passes downwards and backwards from the umbones to the posterior inferior angle, preserving its form, though somewhat expanded and less elevated to the edge of the shell. The anterior end has a blunt convex border, continuous with the inferior border, which is straight and directed downwards and backwards, having the byssal notch about the middle

point, the notch being chiefly in the right valve. The posterior border forms an obtuse angle above with the hinge-line, from which point it slopes downwards and backwards, becoming bluntly truncate below, or even subangular, where it comes in contact with the inferior border.

The hinge-line is straight, equal to about two thirds of the length of the shell, and would, if produced forwards, make a very acute angle with a line drawn in the direction of the inferior border. The umbones are obtuse, not quite terminal, produced forwards, non-contiguous, continuous below with the oblique ridge. The byssal furrow anterior to the ridge is oblique, broad, and much more marked in the right valve than in the left.

Interior.—The same conditions obtain in this form which I have noted in the preceding species, but the anterior muscle-pits are closer together and smaller on account of the size of the shell.

Exterior.—The lines of growth have the same general arrangement which exists in the other species of this genus, modified of course according to the difference of shape which is characteristic of the present shell, but on the whole the lines of growth are closer and more numerous than in other species.

Dimensions (Fig. 31, Pl. XVIII):

Antero-posteriorly	26 mm.
Dorso-ventrally	13 mm.
From side to side	10 mm.

Localities.—The Knowles or Winghay Ironstone of North Staffordshire.

Observations.—This is an interesting species, making as it does by its external appearance a link between Naiadites and Anthracomya, *Naiadites elongata* very closely resembling *Anthracomya minima*. The resemblance is so close that it is impossible to separate imperfect examples; and it has occurred to me that this may be an example of protective mimicry rather than an actual closer connection between the two genera. The examples of *N. elongata* which have occurred to me nearly all possess the shell well preserved, and therefore the characteristic anterior triple muscular scars are not available for generic determination, but I have satisfied myself that they are present.

The umbones, too, have the distinctive appearance which obtains in Naiadites; but, being small and inconspicuous, are often not well freed from their matrix, which as far as I can find at present is always ironstone, and on this account very difficult to remove. Another distinctive feature which may be relied upon to distinguish Naiadites from Anthracomya is the inequality of the valves in the former. This is always present, though less marked in this species than in others. The absence or presence of a byssal notch is another important distinction, being always present in Naiadites. From a study of a series I have come to the conclusion that when young the shape of the shell

differs much from that which subsequently the full-grown specimen assumes, being much more oblique, and having the posterior end much more expanded comparatively to the rest of the shell. (Pl. XVIII, figs. 34 and 35.)

6. Naiadites obesa, *R. Etheridge, jun.*, 1878. Plate XIX, figs. 1—16.

	Anthracoptera ? obesa, *R. Etheridge, jun.*	Quart. Journ. Geol. Soc., vol. xxxiv, pp. 12, 13, pl. i, figs. 12, 13 (and 14 ?), 1878.
	Anthracoptera tumida, *R. Etheridge, jun.*	Memoirs of the Geol. Surv. Scotland, Expl. of Sheet 31, p. 82, 1879.
	Myalina modioliformis, *Kirkby.*	Quart. Journ. Geol. Soc., vol. xxxvi, p. 585, 1880.
	Anthracoptera obesa, *Hind.*	Ibid., vol. xlix, p. 255, 1893.
	— tumida (pars), *Hind.*	Ibid., vol. xlix, p. 255, 1893.
Non	— — —	Ibid., vol. xlix, p. 255, pl. vii, figs. 13, 14.

Specific Characters.—Shell tumid, transversely triangular, with a strong diagonal blunted gibbosity or ridge dividing the valves into two nearly equal diagonal halves, more pronounced in the left valve. The anterior end is tumid but small, obtusely pointed, marked off by a very shallow and oblique constriction anterior to and parallel to the ridge. The anterior border is bluntly curved, pointed above, soon sloping downwards and backwards, so that it passes gradually into the inferior border, which in front is oblique but straight, posteriorly is bluntly rounded or even angulated. The byssal notch, most marked in the left valve, is situated just anterior to the point where the oblique swelling becomes marginal. The posterior end is obliquely truncated from above downwards and backwards, making above an obtuse angle with the posterior end of the hinge-line, below becoming rounded off into the lower border.

The hinge-line is straight, somewhat less than the greatest antero-posterior length of the shell. The umbones are obtuse, delicately pointed at tip, which is situated at a point distant from the anterior extremity of the hinge-line equal to one tenth of the length of that line, not contiguous, raised above the hinge-line. Umbonal swelling is not marked off from the gibbose anterior part of the shell, posteriorly it is continuous with the oblique diagonal ridge, which is very marked in its upper two thirds and best defined on its anterior side; posterior to the ridge the shell becomes gradually compressed, more especially upwards where the posterior slope is convex. The ridge is almost median, but really slightly anterior to the true diagonal of the shell.

Interior.—Anteriorly there are only two muscle-pits, but the lower is very large, and probably represents the two lower scars of other species. The upper or smaller scar is in its proper situation. The posterior adductor muscle scar has not been noted. The pallial line is represented by a series of small pits.

The hinge-plate is striated longitudinally, broad in front, becoming gradually narrow behind. In front the lower edge is thickened and projects as a cardinal tooth, that of the left valve being anterior and above. The anterior edge of the shell is thickened and bevelled at the expense of its outer surface, exposing the layers of shell-matter.

Exterior.—The surface is ornamented with lines of growth, which, crowded in front, soon separate and become parallel to the margins.

Dimensions.—Pl. XIX, fig. 16, measures:

Antero-posteriorly	34 mm.
Dorso-ventrally	25 mm.

Localities.—Scotland:—Micaceous sandstone, Drumsheugh. Water-of-Leith and Dean Bridge, Edinburgh, in the Wardie Shale group of the Cement-stone series. Corstorphine Hill (shale), in limestone above the sandstone of Craigleith quarry, Edinburgh. Shale above the "Brownstone" portion of the Boness lower iron-stone Edge-coal series, Duncan pit. Shingle pit and Cowsie mine, Boness. Zone 6, 40 feet below the Encrinite bed, east of Pittenweem. Zone 11, east of Target, Billowness. Zone 13, below sandstone at Billowness. Zone 14 and 15, east of Billowness. Anstruther Wester, zone 17. Zone 18, west of Dreel Burn. In ferruginous sandstone, opposite Kilrenny mill. Limestone Nos. 2 and 3, Randerstone, east of Kingsbarns' Harbour. Above the bed of coal at the Rock and Spindle, near St. Andrews, all in the Calciferous sandstone series of the Fifeshire coast.

Observations.—This form is sufficiently different from others to merit a specific name, and it appears to be confined to the Lower Carboniferous beds, occurring in the Calciferous-sandstone series and Middle Limestone series of Scotland, and is therefore the earliest known form of this genus in Carboniferous beds. *Naiadites obesa* was evidently gregarious. There are beds on the Fifeshire coast, of one or two feet in thickness, composed of masses of this shell, which extend for a considerable distance. After much laborious field-work, Mr. James W. Kirkby has been able to gather, from portions of such beds which have become decomposed by the action of air and sea-water, several fragments from which the internal anatomy of the shell has been made out, so that the characters of this, the earliest known form, are known even better than the more recent.

Mr. Kirkby at first gave the MS. name of *Mytilina communis* to this shell, but subsequently, in his paper (*op. supra cit.*) he doubtfully referred it to *Modiola modioliformis*, Brown, 'Foss. Conch.,' pl. lxvi, fig. 19. This, however, Mr. R.

Etheridge, jun., pointed out to be probably a dwarfed form of *Myalina crassa*, Fleming, a conclusion which I think to be probably correct. *Naiadites obesa*, Etheridge, and *Naiadites crassa*, var. *modioliformis*, have really little in common, and Mr. Etheridge does not, in his observation on the new species, mention any connection between them.

I made a visit to the Fifeshire coast to obtain specimens, and Mr. Kirkby generously placed all his material in my hands, so that I have been able to examine a large number of specimens which I have compared with the originals of the figures of Mr. Etheridge's *Anthracoptera obesa*, in the Museum of Science and Art, Edinburgh, and with a series of eleven specimens from Boness, kindly lent to me from the Geological Survey Collection of Scotland, which are doubtless the shells which served for Mr. Etheridge's description; and after careful examination I have come to the conclusion that the Calciferous Sandstone shell and the Boness specimens belong to the same species. In the Calciferous Sandstone beds of the Fifeshire coast, Mr. Kirkby has shown that *Naiadites obesa* is found accompanied by several Ostracoda. *Beyrichia subarcuata*, *Carbonia fabulina*, *C. subula*, *C. Rankiniana* or *bairdiodes*, *Leperditia Okeni*: *Cythere*, sp.; *Spirorbis*; Fish (Rhizodus) remains; a small Gasteropod; *Littorina Scotoburdigalensis*, Etheridge, of doubtful genus, *Carbonicola antiqua* (Hind), and plant remains.

In only one case, that of Zone 12 (*op. cit.*, page 568) does Mr. Kirkby find this shell with typical marine forms, Lingula and Schizodus, but this bed of shale is in close contact with a limestone containing the usual fauna and flora which accompany *N. obesa*. No other fossil remains are said to occur with the shells in the Boness beds.

Now that I have been able to see a large number of shells, I find that the specimens which I figured (*op. sup. cit.*) as *Anthracoptera tumida* from North Staffordshire are only very obese forms of *N. carinata* (see p. 140, and Pl. XVIII, figs. 13, 14, and 16). In fact I have not met with this form out of Scotland.

I have little doubt that Mr. Etheridge's two forms are really the same species. It will be noticed in the original paper that he is somewhat in doubt as to the true genus of his shell, and places the mark ? after the generic name. In his observations he points out that his shell closely resembles some forms of Myalina, from which he separates it because he saw no trace of the striated hinge-plate. It is very curious how completely this character is hidden when the fossils are embedded in matrix, or the two valves in proper apposition.

By the kind permission of the Director of the Science and Art Museum, obtained for me by Dr. Traquair, I refigure one of the type specimens, Pl. XIX, fig. 16; but it differs much from the other figures given of the same shell. This is a full-grown and large example, and many shells of the same size occur in the shore beds opposite Kilrenny Mill, Fife, while those like the other type figures are common,

and are evidently younger forms. Mr. Etheridge says: "The much more central position of the diagonal ridge, greater convexity of the shell, and the sigmoidal margin of the posterior end"—the latter character, however, is not shown in the large type-specimen,—"at once distinguish *A. obesa* from" *A. carinata*, *A. quadrata*, and *A. modiolaris*. These shells, however, all at times have a sigmoidal posterior margin, and *A. carinata* is often very much swollen; but I regard the more central position of the diagonal ridge, and its obesity, as characteristic features. It is just these points that Mr. Etheridge also advances as diagnostic of his other species, *Anthracoptera tumida* at p. 82 of the 'Memoirs of the Geological Survey of Scotland,' Explanation of Sheet 31, where he says: "*A. tumida* has for its essential characters the great tumidity of the valves, strong and nearly median diagonal ridge, and prominent beaks." He states, however, further on that "the general outline of *A. tumida* approaches much nearer to another species of the same genus lately described by me, *A.? obesa*, but many of the points already indicated will also serve as distinctive ones in this case." On carefully comparing both descriptions, there is no real point of distinction offered, and I cannot but think that both *A. obesa* and *A. tumida* belong to the same species, which therefore retains the name of *obesa*. The shells from Boness in the Survey Collection are all more or less crushed and pressed out of shape. I figure three of the most perfect, Pl. XIX, figs. 12—14. At page 80 I pointed out that I suspected the identity of the shell from the Kilrenny Mill beds with Mr. R. Etheridge's *A.? obesa*, but at that time I had not satisfied myself that an anterior hinge-tooth was present in the genus Naiadites; in fact it was the presence of a well-marked tooth in the form that made me search for traces of it in the other species of the genus Naiadites, with the result that I found distinct traces of it in most species.

7. Naiadites crassa (Fleming). Plate XX, figs. 1—11.

Modiolus, sp., *Fleming*. Edin. Phil. Journ., vol. vii, p. 246, pl. ix, fig. 3, 1825.
Mytilus crassus, *Fleming*. British Animals, p. 412, 1828.
Modiola, sp., *Rhind*. Age of the Earth, p. 167, pl. ii, fig. *g*.
Avicula modioliforme (*sic*), *Brown*. Foss. Conch., p. 162, pl. lxvi*, fig. 19, 1849.
Mytilus (myalina) crassus, *King*. Mon. Perm. Foss. Eng., Palæontograph. Soc., p. 159 (no description), 1850.
— crassus, *Morris*. Cat. Brit. Foss., 2nd edit., p. 214, 1854.
Avicula modioliformis, *Morris*. Ibid., 2nd edit., p. 162, 1854.
— — *Salter*. Memoirs Geol. Surv. Scotland, No. 32, p. 146, 1861.
Myalina crassa, *Huxley and Etheridge*. Cat. Foss. Mus. Pract. Geol., p. 110, 1865.

MYALINA CRASSA, *R. Etheridge, jun.* "On Carboniferous Lamellibranchiata," Ann. Mag. Nat. Hist., ser. 4, vol. xv, p. 427, pl. xx, figs. 1—5, 1875.

— — var. MODIOLIFORMIS, *R. Etheridge, jun.* "Invertebrate Fauna of Lower Carb.," Quart. Journ. Geol. Soc., vol. xxxiv, pp. 13, 14, 1878.

— — *R. Etheridge.* Foss. Brit. Palæoz., p. 286, 1888.

ANTHRACOPTERA CRASSA, *Hind.* Geol. Mag., dec. 3, vol. x, p. 514, 1893.

Specific Characters.—Shell transversely produced, large, triangular, massive. The anterior end is swollen, for the greater part solid, acutely pointed above, forming a small lobe in front of the beaks. The anterior border very thin, and showing layers of shell above, slopes rapidly downwards and backwards, being only slightly convex at first; the edge of the shell then becomes thin and sinuous, in the centre of which is the byssal notch, much more pronounced in the left valve. From the byssal notch the lower border is almost straight, but still directed obliquely downwards and backwards. The posterior end includes the greater portion of the shell, and has a truncate posterior border very slightly obliquely cut from above downwards and backwards; it joins the inferior side by a bluntly rounded curve, and above forms an obtuse angle with the posterior end of the hinge-line, which is straight, only very slightly shorter than the extreme length of the shell. The umbones are anterior, not quite terminal, small, and pointed, very slightly elevated above the hinge-line; in unworn specimens a little incurved at the apices so as to project over the hinge-line. From the umbones a well-developed oblique gibbosity, more conspicuous in the left valve, extends across the shell downwards and backwards towards the inferior border, which it reaches some distance in front of the posterior inferior angle of the shell. Anterior to this swelling the shell is much constricted, the left valve being the more so. This constriction becomes broader and shallower as it approaches the edge of the shell, where it corresponds to the sinuosity of the margin and the byssal sinus. Posteriorly the oblique gibbosity becomes compressed, especially upwards into the hinge-line, so that the shell becomes flat towards the posterior end, and the valves must here be almost in contact.

Interior.—The anterior adductor impressions are double, often triple, pit-like. When triple, the middle scar is the largest. The posterior adductor scar is large, shallow, very delicately ribbed, situated on the posterior slope some little distance within the margin of the shell. The marks for the insertion of the byssal muscles are seen just below the hinge-line. The inner surface of the shell is smooth. Its pallial line is some little distance within the valves, marked by a row of pits which in some specimens have coalesced into a continuous line.

The hinge-plate is elongated, broad in front, becoming narrow behind, very

slightly bevelled at the expense of its upper edge; longitudinally striated, in old specimens as many as fifteen striæ; these, thickened and less defined, are continued round to the thickened, anterior border. In front the lower edge of the hinge-plate is thickened forming an ill-defined tooth, that of the left valve being anterior to that tooth in the right.

The shell substance is very thick, and in front encroaches much on the cavity for the animal. Posteriorly it becomes much thinner, and is rarely preserved. The apex of the cavity of the shell does not at all correspond with the exterior, being below and behind the real anterior point of the shell.

Surface ornamented in a similar way to that of other members of the genus.

Dimensions.—Pl. XX, fig. 10, a cast of the interior, from Beith, measures:

Extreme antero-posterior diameter . .	76 mm.
Greatest dorso-ventral (posterior end) . .	48 mm.
From side to side	30 mm.

Localities.—Scotland:—Cult's Limeworks near Pitlessie, Fife, in bed of shale over the Mountain-Limestone. Lugton Water, near Dunlop, Ayrshire; Lower Carboniferous Limestone, Woodhall; Water of Leith. Roughwood and Lyon-shields, Beith, in a shale below the Main Post of the Lower Limestone Series.

Observations.—I have already referred to the reasons why I have placed this shell in the genus Naiadites, and have discussed the question of its habitat. *Naiadites crassa* has been known to palæontologists since 1825, but has only been figured by Dr. Rhind and Mr. R. Etheridge, jun. I fancy that the former has figured the smaller or dwarfed form (from the Water-of-Leith), noticed at p. 150. Mr. Etheridge's figures and description are very good and typical. In his observations, however, he quotes M'Coy's opinion as to the third or uppermost of the anterior adductor scars being for the insertion of the adductor of the opposite valve. He states too: "immediately in front and within the angle formed by the hinge-plate and the anterior margin is another shallower depression, from which a depressed and more or less interrupted line runs in many specimens across the cartilage area, sometimes even interrupting the furrows themselves." He suggests that the rim or margin, described above, represents the rostral plate of Myalina and Dreissenia. This line and depression are very often absent, and I am inclined to attribute the presence of them to accidents of growth and environment.

The only member of the genus Naiadites which attains anything like the size of *N. crassa* is *N. magna*, but they are very dissimilar, and occur at very different horizons, though both forms have as yet been found only in Scotland.

It is curious to note how very many specimens of this shell obtained from the Cults beds have been damaged and repaired during life. This mussel-bed must have occupied a very exposed position, perhaps off some headland, where they were at the mercy of a strong tidal wave; and in this bed it is very rare to find

the two valves of any specimen in apposition, which seems to point to the fact that this exposure to violence, after the death of the mollusc, caused a separation of the two valves of the shell. The beds at Beith seem to have been subjected to violence, few perfect specimens being found there, though this locality has furnished the bivalve examples figured on Pl. XX, figs. 9 and 10.

A slighter form of this shell, found in several localities, was mentioned by Mr. R. Etheridge, jun., in his paper "On our Present Knowledge of the Invertebrate Fauna of the Lower Carboniferous or Calciferous Sandstone Series of the Edinburgh neighbourhood, especially of that division known as the Wardie Shales, and on the first appearance of certain Species in these Beds" ('Quart. Journ. Geol. Soc.,' vol. xxxiv, p. 13, 1878; read November 7th, 1877), under the term *Myalina crassa* var. *modioliformis*, pointing out that it had been described and figured by Captain Thomas Brown; and I take the figure by Dr. Rhind ('Age of the Earth,' pl. ii, fig. *g*), the original of which is said to have come from Woodhall, Water-of-Leith, to refer to the same form. Indeed, it is very probable that Captain Brown reproduced Dr. Rhind's figure, the two being exactly similar. Mr. Etheridge says: "As I cannot distinguish any characters, either external or internal, by which to specifically distinguish Captain Brown's shell from Dr. Fleming's, I propose to adopt the name given by the former as a varietal designation for the thinner and lighter form of *Myalina crassa*." I have not thought it necessary to preserve the varietal name, agreeing as I do with the observation of Mr. Etheridge that the only difference to be observed is one dependent on environment. The shells from the neighbourhood of Edinburgh are undoubtedly of much slighter build and somewhat undersized, and they are said to occur with *Schizodus Salteri* above and below a marine shale.

This stratigraphical arrangement points to changes of conditions which were doubtless inimical to the robust growth of the shell, and I find that, judging from the specimens I have seen, the shells of Schizodus are also somewhat dwarfed. The beds may have occupied a position near the mouth of a great river, where the volume of fresh water laden with mud proved hostile to the Mollusca which lived in or just beyond the estuary. It should, however, be noted that these slighter forms are the older in point of age, the Calciferous-Sandstone Series being older than the Carboniferous-Limestone beds of Cults and Beith, and that these forms are really the ancestors of those which, under a series of more favourable conditions, grew so luxuriantly at the two localities just mentioned.

8. NAIADITES MAGNA, sp. nov., *Hind.* Plate XIX, figs. 17—20.

Specific Characters.—Shell moderately large, globosely subtriangular. The anterior end is somewhat compressed and almost obsolete, and has the same characters which obtain in other members of this genus. The anterior border is convex, meeting the superior border at an angle which is almost a right angle; below it is produced downwards, joining insensibly the inferior border, which has a downward and posterior direction, sinuated in front and pierced for the byssus. Towards the posterior end the inferior border becomes deflected to the left, forming a shallow depression with the concavity looking towards the right, returning to the middle line at the posterior inferior angle, which is blunt and often the situation of a triple S-shaped folding, the sulci of which are to be traced upwards on the body of the posterior and lower part of the shell. The posterior border is truncate from above downwards and backwards, making an obtuse angle above with the superior border, and below is bluntly rounded in direction but folded. The hinge-line is straight, and extends the whole length of the superior border. The umbones are obtuse and swollen, at first directed inwards to the middle line, but before they reach it are bent sharply on themselves forwards, where they terminate on either side of the anterior superior angle; widely separated in casts, and only slightly raised above the hinge-line. From the umbones a very gibbose and broad oblique swelling, bounded in front by an almost obsolete oblique depression, passes downwards and backwards, becoming broader as it nears the margin, near which it becomes broken up into two or more ridges with intervening depressions, the ridges in the left valve being anterior to those in the right and opposite the depressions on the right valve. Above the oblique swelling the shell is rapidly compressed and expanded upwards into the posterior part of the hinge-line, so that the posterior slope of the shell is concave. The greatest convexity of the shell is only slightly below the hinge-line. The inequality of the valves is not so marked as in other species of this genus.

The interior has a normal arrangement. Pallial line pitted, entire, and remote from the edge of the shell. The anterior muscular impressions are trifid, the most anterior being the largest. The position of the posterior adductor muscle has not been exposed. There is a shallow groove on each side of the median line, becoming deeper and broader posteriorly for the thickened lower margin of the hinge.

Exterior.—The surface is almost smooth, and covered with fine striæ and lines of growth; near the margin the lines of growth are closer, rougher, and more distinct.

Dimensions :

	Antero-posteriorly.	Dorso-ventrally (greatest length).	From side to side.
Pl. XIX, fig. 20, measures	50 mm.	35 mm.	30 mm.
Pl. XIX, fig. 19, ,, .	45 mm.	30 mm.	23 mm.

Locality.—Scotland :—Black Band Ironstone, Bankend, Lesmahagow.

Observations.—I am indebted to Dr J. S. Hunter, of Braidwood, for the loan of and permission to describe and figure these specimens, which are second in size only to *N. crassa* of the Carboniferous Limestone. These shells can be distinguished from all others by the alternate fluting of the valves at the posterior inferior angle, a character which is not very apparent in young specimens (Pl. XIX, figs. 17 and 19), but becomes more developed with age.

The shape and general appearance of the shell at first suggested a reference to Mr. Etheridge's *Anthracoptera obesa*, but from this form *N. magna* is distinguished by its more obtuse gibbosity, not so nearly central, and the folding of the posterior inferior angle of the shell, a character I have observed in no other species of this genus.

Mr. Etheridge says that the posterior margin of his shell is sigmoidal, and this is shown only in one of his figures ; but this curve refers to the margin only, and must not be thought to apply to the peculiar crumpling of the posterior inferior angle of *N. magna*, a character which is shown to be absent in all figures of *N. obesa*.

N. magna occurs at a much higher horizon than *N. obesa*, having been obtained up to the present time only from the Blackband ironstone, placed, in the ' Geological Survey Memoirs,' Explanation of Sheet 23, p. 80, at the base of the middle beds of the Carboniferous Limestone Series. Judging from the Bankend section given at p. 32 of the same memoir, there is only one Blackband ironstone, the position of which is given about the centre of these middle beds; and at p. 26 the main Lesmahagow gas coal, which is stated at p. 80 to overlie the Blackband ironstone, is again given as follows :

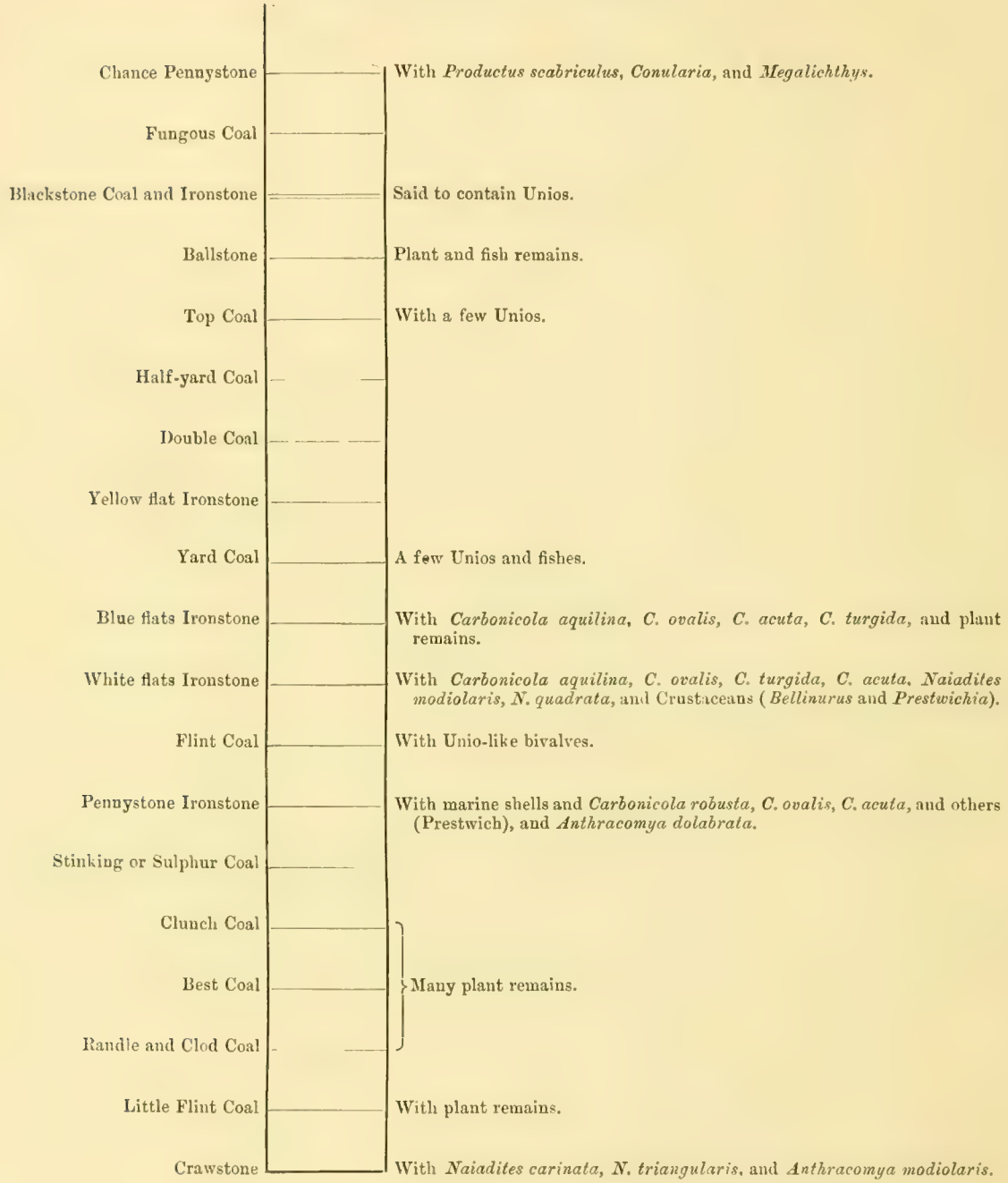
		Ft.	Inch.
Upper Group	. . . . .	232,	5.
Middle Group	Strata with their coals and clay ironstone .	188,	0.
	Main Lesmahagow Gas Coal . .	1,	10.
	Strata	165,	0.
Lower Group	. . . . .	114,	9.

§ IV. DISTRIBUTION.

It has been considered advisable, in order to give a graphic idea of the horizontal distribution of the various species of the genera Carbonicola, Anthracomya, and Naiadites, that diagrammatic sections of each of the coal-fields and of other Carboniferous strata in which they occur should be given. I have therefore compiled such a series of stratigraphical tables from actual pit-sections, and also from vertical tables given of the various Coal-fields in the 'Memoirs of the Geological Survey,' and in Professor Hull's 'Coal-fields of Great Britain.' These sections are only intended to show the succession of strata and relative position of the shell-bearing beds in the various districts, and, except where indicated, are not drawn to scale. Wherever the species occurring in any bed are given, I have personally identified them in Collections; and the localities in these lists are therefore more definite and more accurate than those in the text. Of course there are probably many more horizons at which mussel-bands occur, but these have either not been recorded, or no specimen from them has come to hand for identification.

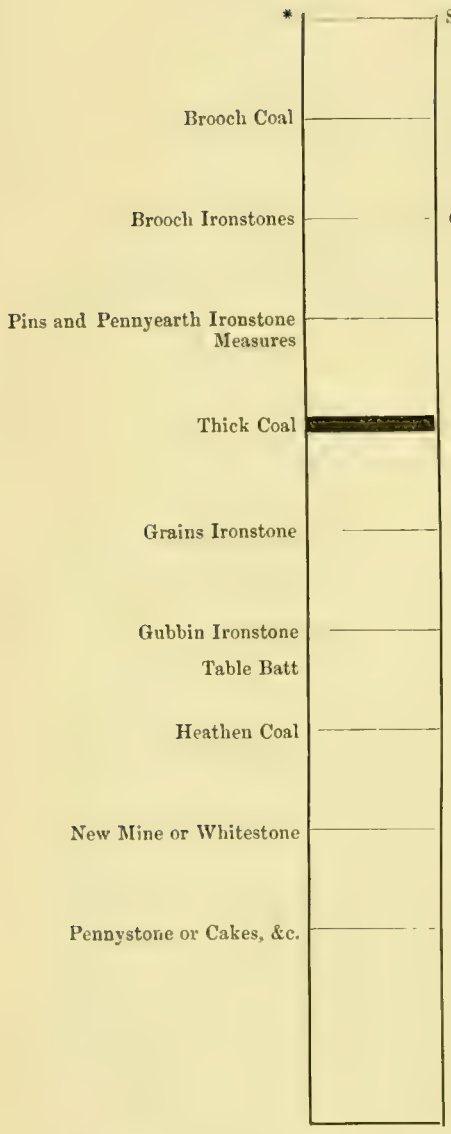
I am specially indebted to Mr. James W. Kirkby and Mr. John Smith for the sections of the Fifeshire and Ayrshire Coal-fields, and to the former also for permission to copy his section of the Calciferous Sandstone Series of Fife. In those cases where no section of a coal-field mentioned in the text is given, the omission is due to the absence of the necessary detailed information.

1. Coal-field of Coalbrookdale.


Chance Pennystone
With *Productus scabriculus*, *Conularia*, and *Megalichthys*.
Fungous Coal
Blackstone Coal and Ironstone
Said to contain Unios.
Ballstone
Plant and fish remains.
Top Coal
With a few Unios.
Half-yard Coal
Double Coal
Yellow flat Ironstone
Yard Coal
A few Unios and fishes.
Blue flats Ironstone
With *Carbonicola aquilina*, *C. ovalis*, *C. acuta*, *C. turgida*, and plant remains.
White flats Ironstone
With *Carbonicola aquilina*, *C. ovalis*, *C. turgida*, *C. acuta*, *Naiadites modiolaris*, *N. quadrata*, and Crustaceans (*Bellinurus* and *Prestwichia*).
Flint Coal
With Unio-like bivalves.
Pennystone Ironstone
With marine shells and *Carbonicola robusta*, *C. ovalis*, *C. acuta*, and others (Prestwich), and *Anthracomya dolabrata*.
Stinking or Sulphur Coal
Clunch Coal
Best Coal
Many plant remains.
Randle and Clod Coal
Little Flint Coal
With plant remains.
Crawstone
With *Naiadites carinata*, *N. triangularis*, and *Anthracomya modiolaris*.

Note.—In Professor Prestwich's monograph the name Unio is given to Carbonicola, Anthracomya, and Sanguinolites, so that it is uncertain, where Unio-like shells are said to occur in a bed without specific name, as to which of these genera they belong. In the list, however, at pp. 491, 492 of his work marine shells are stated to occur only in the Pennystone and Chance Pennystone beds.

2. South-Staffordshire Coal-field.



Shale above the Brooch Coal contains *Carbonicola acuta* and *C. similis.*

Carbonicola aquilina; very plentiful.

Carbonicola aquilina, C. nucularis, Anthracomya modiolaris, Naiadites modiolaris, N. carinata, and *N. triangularis.*

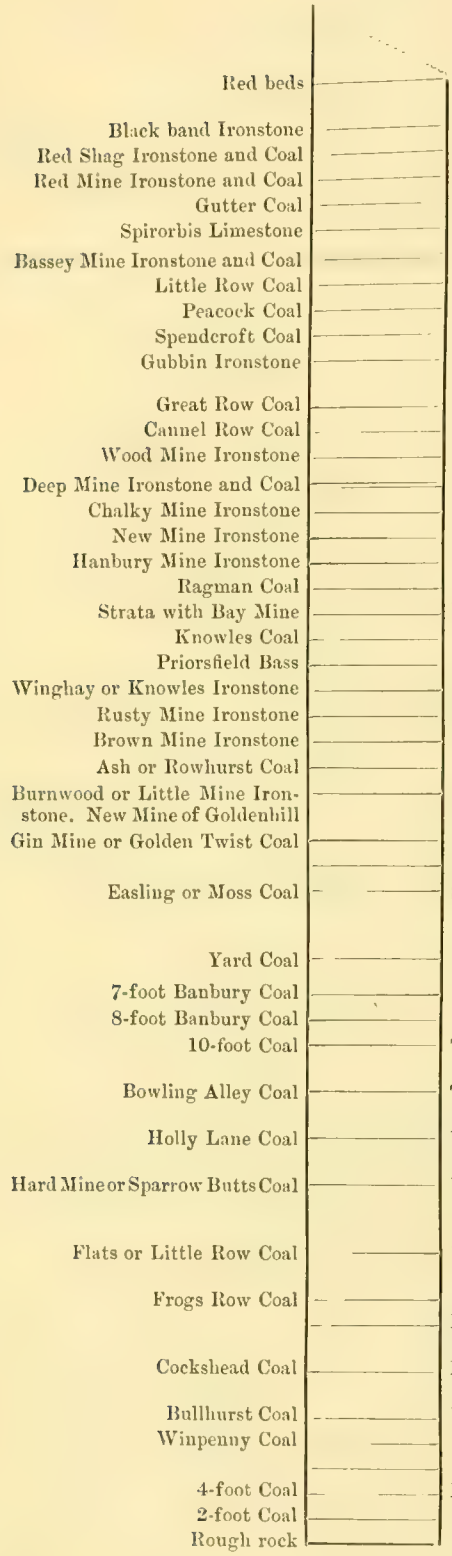
Carbonicola acuta, C. aquilina, Anthracomya turgida, Naiadites modiolaris, and *N. carinata.*

"Near Oldbury fossil shells are abundant in the upper part of the cakes and bottom of the Whitestone,—both the shells known formerly as Unio, and now called Cardinia and Anthracosia, and others, such as *Producta, Aviculopecten*. . . . . It is remarkable that the shells called Cardinia are *never,* or very rarely, mingled in the same mass of stone with any of the other shells, except in rare instances with a solitary Lingula" (Beete Jukes, 'Iron Ores of Great Britain,' pt. ii; 'The Iron Ores of the South Staffordshire Coal-field,' pp. 111, 112.

I can find no record of Mollusca from any beds below the Pennystone.

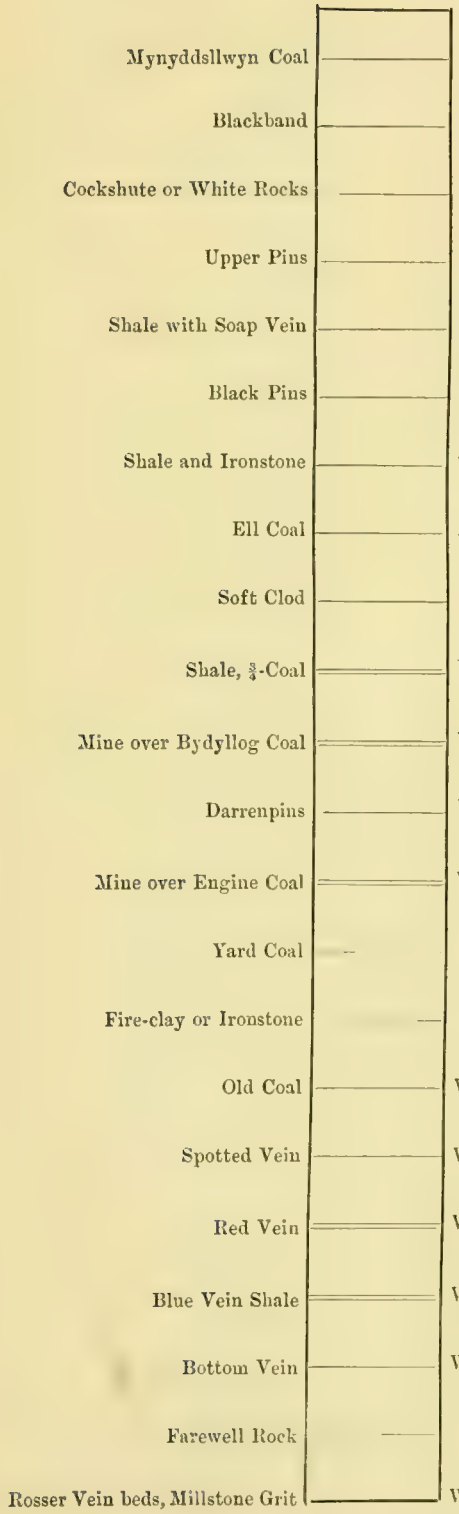
* At the Hamstead Colliery a band of marine fossils was passed through at 60 yards above the Thick Coal. Prof. Hull gives the Brooch Coal as 43 yards above the Thick Coal. This band was said to contain *Anthracosia Urei,* which is probably a mistaken reference.

3. North Staffordshire Coal-field.



Red beds	With *Anthracomya Phillipsii* and Ostracoda at 828 feet from the surface in the Trentham boring.
Black band Ironstone	These Ironstones are fissile and well stratified, and are filled with *Anthracomya Phillipsii*.
Red Shag Ironstone and Coal	
Red Mine Ironstone and Coal	
Gutter Coal	Plant remains.
Spirorbis Limestone	With *Ancylus Vinti*.
Bassey Mine Ironstone and Coal	Ironstone is crammed with *Anthracomya Phillipsii*.
Little Row Coal	Plant remains.
Peacock Coal	
Spendcroft Coal	
Gubbin Ironstone	With *Anthracomya Phillipsii*.
Great Row Coal	Plant bed.
Cannel Row Coal	With fish remains.
Wood Mine Ironstone	
Deep Mine Ironstone and Coal	
Chalky Mine Ironstone	
New Mine Ironstone	
Hanbury Mine Ironstone	
Ragman Coal	
Strata with Bay Mine	With marine mollusca, *vide* p. 7.
Knowles Coal	
Priorsfield Bass	
Winghay or Knowles Ironstone	With *Anthracomya minima*, *A. Phillipsii*, and *Naiadites elongata*.
Rusty Mine Ironstone	
Brown Mine Ironstone	
Ash or Rowhurst Coal	
Burnwood or Little Mine Ironstone. New Mine of Goldenhill	With *Anthracomya Adamsii* and *A. dolabrata* in upper band, and *Anthracomya pulchra* and *Naiadites modiolaris* in the lower.
Gin Mine or Golden Twist Coal	Marine band, *vide* p. 7.
	Dark indurated clay with Lingula.
Easling or Moss Coal	Shales above the Moss Coal contain *Carbonicola acuta*, *C. aquilina*, *C. turgida*, *C. gibbosa*, *C. subrotunda*, *C. obtusa*, *Naiadites carinata*, and *N. modiolaris*.
Yard Coal	With *Carbonicola acuta*, dwarfed, in the roof at Chesterton.
7-foot Banbury Coal	
8-foot Banbury Coal	
10-foot Coal	The roof contains *Carbonicola acuta*, *C. robusta*, *C. obtusa*, *Naiadites modiolaris*, *N. triangularis*, and *N. carinata*.
Bowling Alley Coal	The roof contains *C. aquilina*, *C. obtusa*, *Anthracomya Wardi*, *A. modiolaris*, *Naiadites modiolaris*, and *N. carinata*.
Holly Lane Coal	With a bed of shale a little way above it containing *Carbonicola aquilina*, *Naiadites modiolaris*, and *N. carinata*.
Hard Mine or Sparrow Butts Coal	With *Carbonicola aquilina*, *C. nucularis*, *C. cuneiformis*, *Anthracomya Williamsoni*, *A. senex*, *A. subcentralis*, *Naiadites modiolaris*, *N. carinata*, *N. triangularis*, and *N. quadrata*.
Flats or Little Row Coal	With *Carbonicola acuta*, and *C. aquilina* in abundance in the roof.
Frogs Row Coal	
	Rock with *Anthracomya senex*, *Carbonicola similis*, and shale with *Carbonicola obtusa*.
Cockshead Coal	Black shale roof full of *Carbonicola acuta*, *C. acuta*, var. *rhomboidalis*, and *C. similis*.
Bullhurst Coal	With *Carbonicola acuta* and *Naiadites modiolaris* at Halmerend.
Winpenny Coal	
	Bed of fissile shale with dwarfed Lingula.
4-foot Coal	Beds of shale with *Carbonicola acuta* and *C. aquilina*.
2-foot Coal	
Rough rock	

4. Coal-field of South Wales.



Mynyddsllwyn Coal

Blackband — With *Anthracomya* (*Phillipsii ?*).

Cockshute or White Rocks

Upper Pins

Shale with Soap Vein — With *Anthracomya Adamsii* and plant remains; and with *Carbonicola aquilina*, *C. acuta*, and *? C. turgida* in the Pennypieces which are supposed to be at about the horizon of the Soap Vein at Ynys-cedwin.

Black Pins — With *Carbonicola acuta* and plant remains.

Shale and Ironstone — Plant remains.

Ell Coal — Plant remains.

Soft Clod — *Carbonicola turgida.*

Shale, ¾-Coal — With *Anthracomya pumila* and *A. subcentralis.*

Mine over Bydyllog Coal — With *Athyris planosulcata.*

Darrenpins — With *Anthracomya senex*, *A. modiolaris*, *Naiadites modiolaris*, *N. quadrata*, *N. carinata*, *Carbonicola aquilina*, and *C. ovalis.*

Mine over Engine Coal — With *Spirifer bisulcatus* and *Productus scabriculus.*

Yard Coal

Fire-clay or Ironstone

Old Coal — With *Carbonicola acuta* and *C. turgida.*

Spotted Vein — With *Spirorbis carbonarius.*

Red Vein — With *Carbonicola acuta*, *C. turgida*, and other shells.

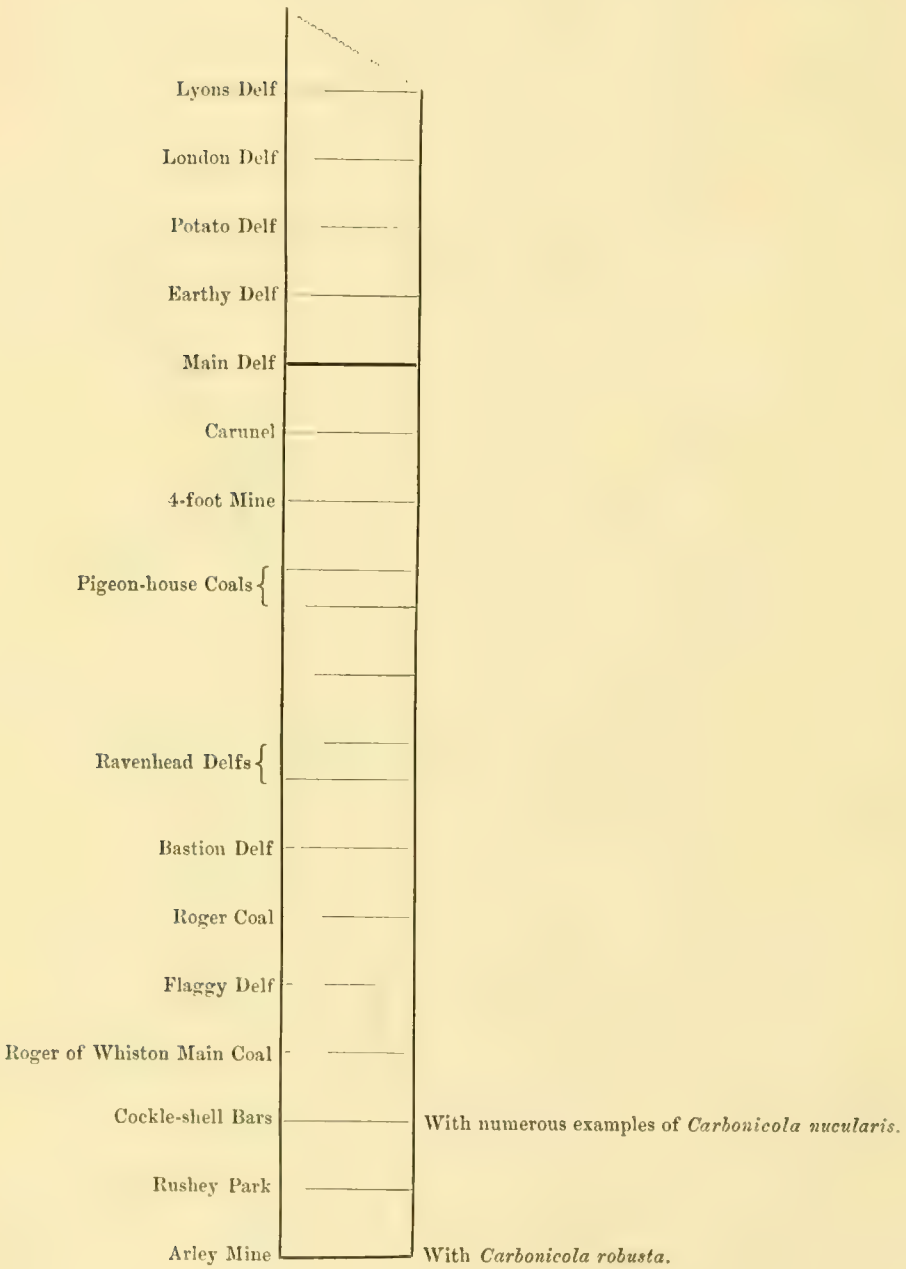
Blue Vein Shale — With *Carbonicola acuta*, *C. turgida*, *Naiadites carinata*, and *Spirorbis carbonarius.*

Bottom Vein — With many fish remains.

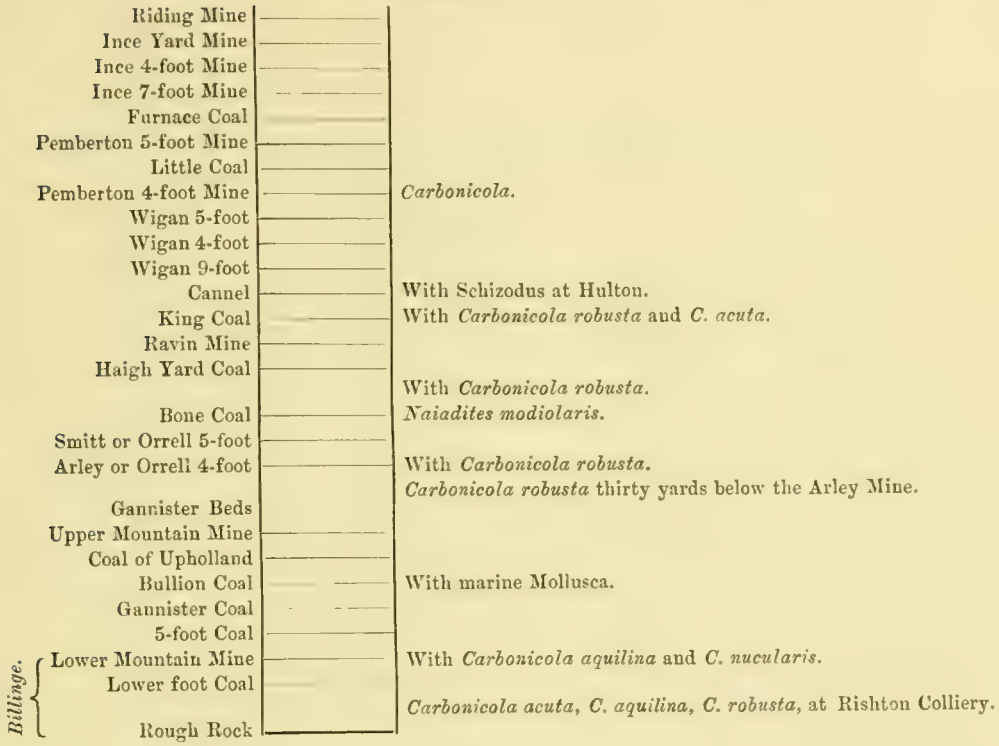
Farewell Rock

Rosser Vein beds, Millstone Grit — With a rich marine molluscan fauna.

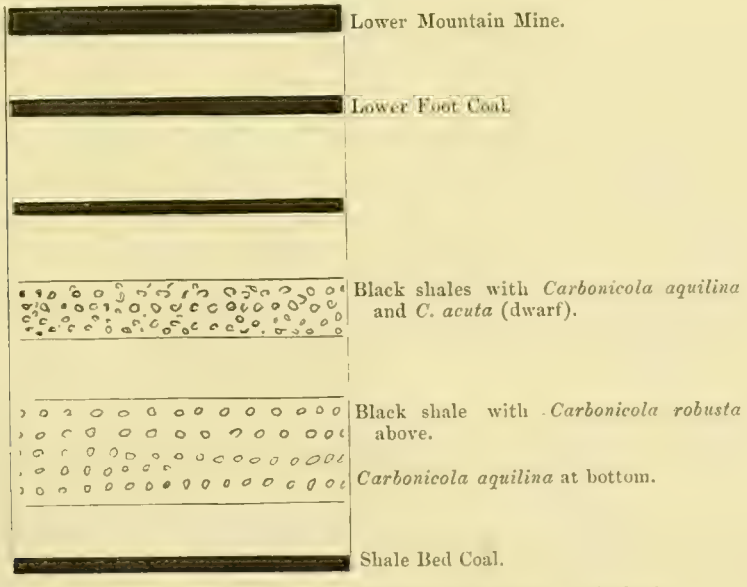
5. West-Lancashire Coal-field—St. Helen's.



6. Lancashire Coal-field—Wigan.

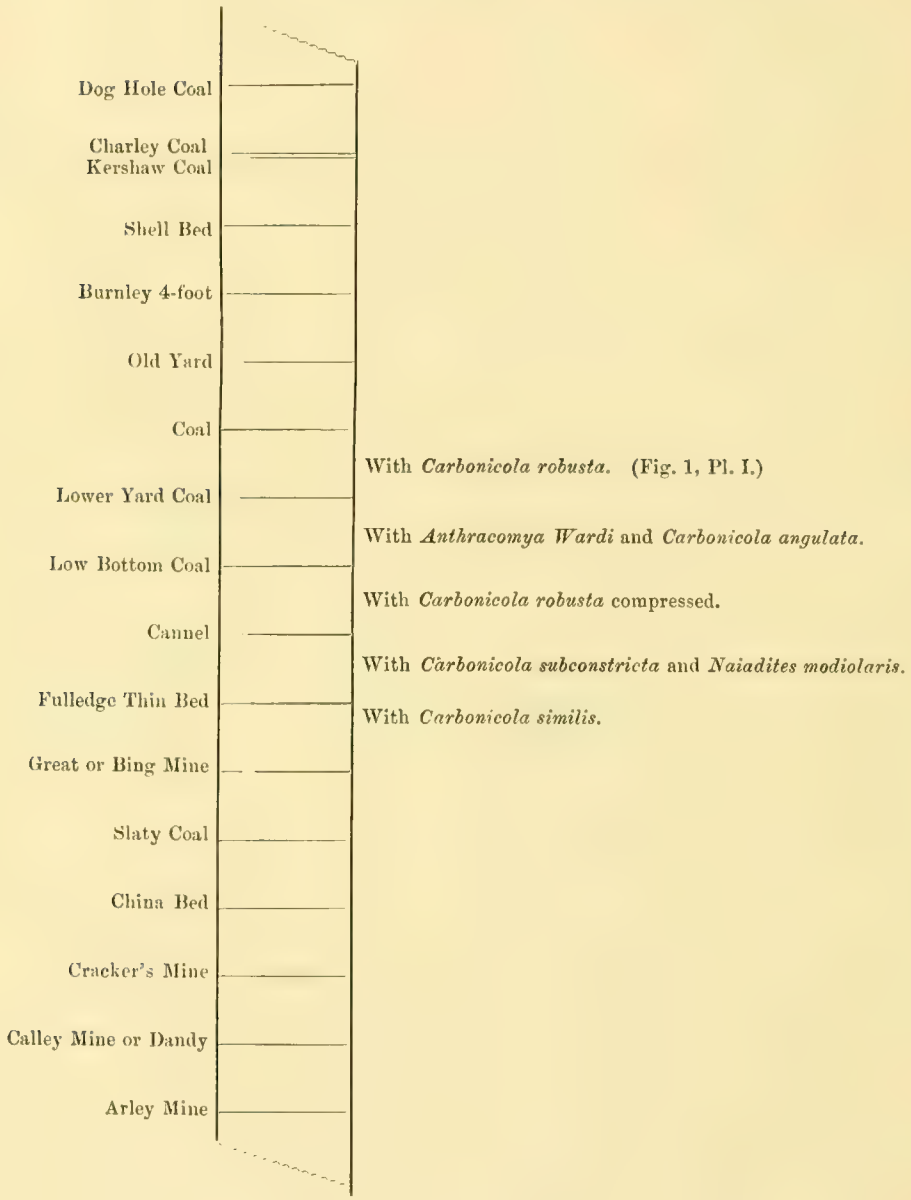


7. Detailed Section of Shell-Beds* below the Lower-Mountain Mine of Rushton Colliery, near Blackburn. Furnished by Wm. Pickup, Esq.

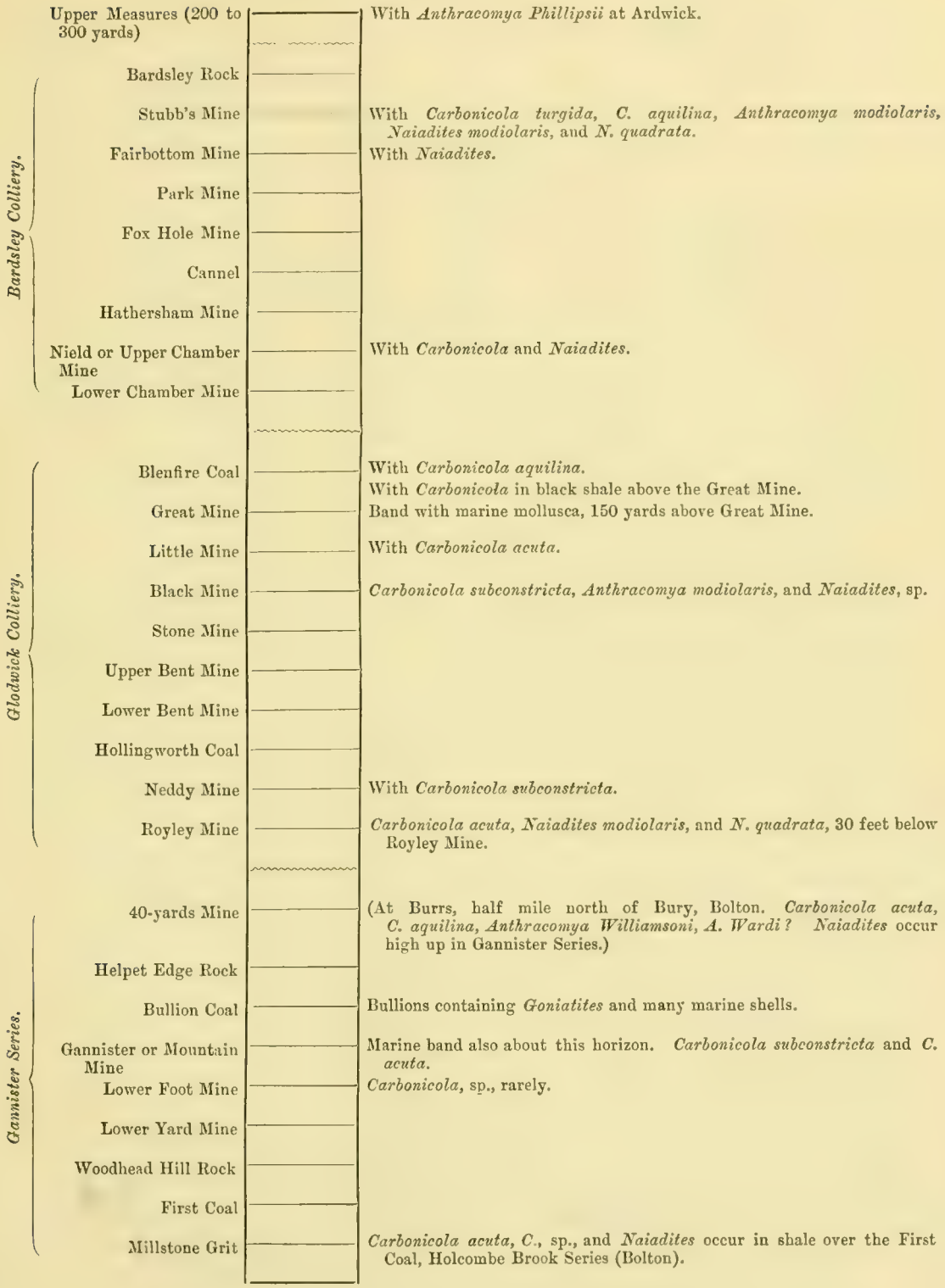

Lower Mountain Mine.
Lower Foot Coal.
Black shales with Carbonicola aquilina and C. acuta (dwarf).
Black shale with Carbonicola robusta above.
Carbonicola aquilina at bottom.
Shale Bed Coal.

* Of course these beds lie at a considerable inclination to the horizon.

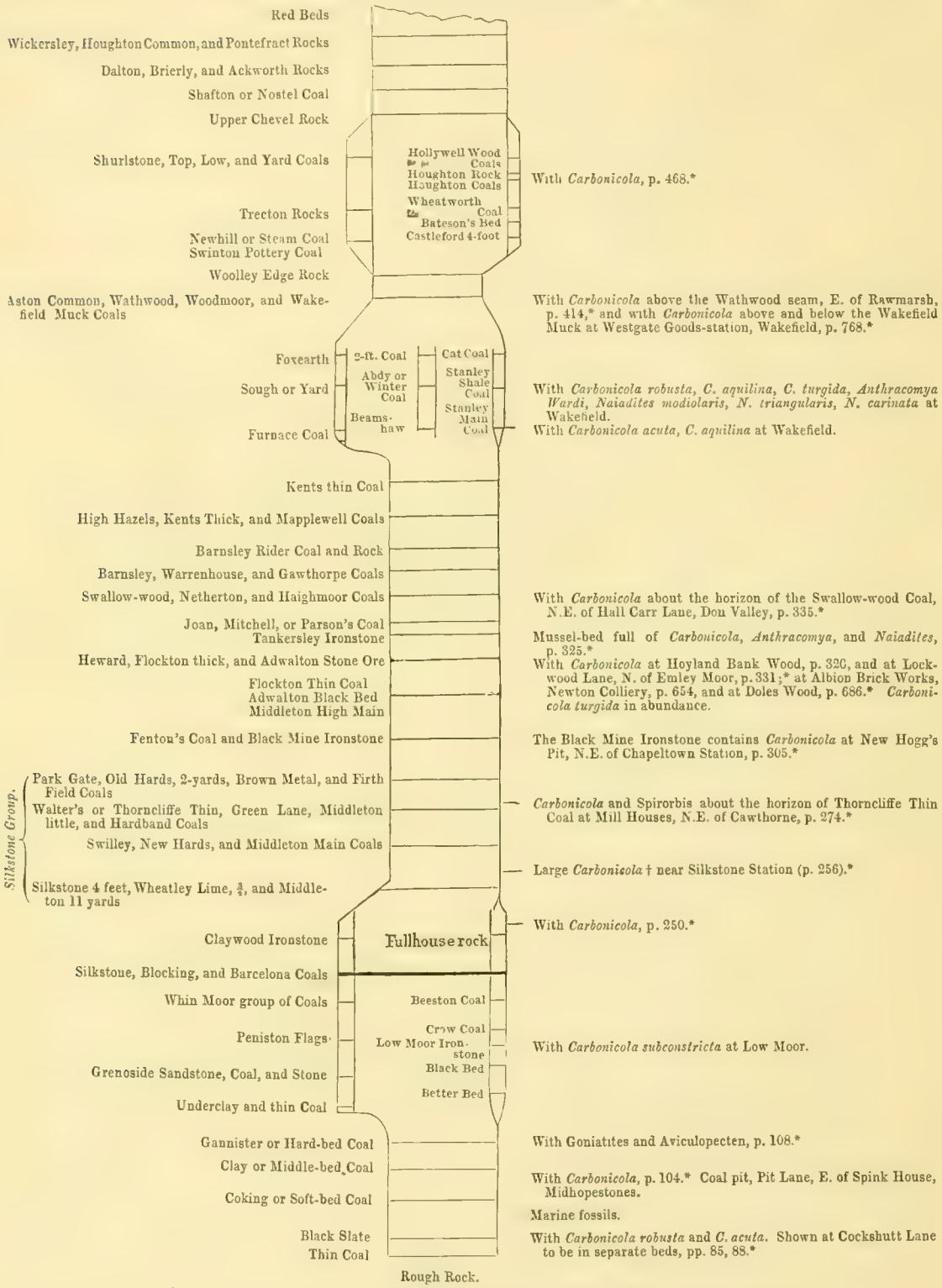
8. Burnley.—Fulledge and Cliviger Sections.



9. Lancashire Coal-field—Oldham District.


Upper Measures (200 to 300 yards)
With *Anthracomya Phillipsii* at Ardwick.
Bardsley Rock
Stubb's Mine
With *Carbonicola turgida, C. aquilina, Anthracomya modiolaris, Naiadites modiolaris,* and *N. quadrata.*
Fairbottom Mine
With *Naiadites.*
Park Mine
Fox Hole Mine
Cannel
Hathersham Mine
Nield or Upper Chamber Mine
With *Carbonicola* and *Naiadites.*
Lower Chamber Mine
Bardsley Colliery.
Blenfire Coal
With *Carbonicola aquilina.*
With *Carbonicola* in black shale above the Great Mine.
Great Mine
Band with marine mollusca, 150 yards above Great Mine.
Little Mine
With *Carbonicola acuta.*
Black Mine
Carbonicola subconstricta, Anthracomya modiolaris, and *Naiadites,* sp.
Stone Mine
Upper Bent Mine
Lower Bent Mine
Hollingworth Coal
Neddy Mine
With *Carbonicola subconstricta.*
Royley Mine
Carbonicola acuta, Naiadites modiolaris, and *N. quadrata,* 30 feet below Royley Mine.
Glodwick Colliery.
40-yards Mine
(At Burrs, half mile north of Bury, Bolton. *Carbonicola acuta, C. aquilina, Anthracomya Williamsoni, A. Wardi? Naiadites* occur high up in Gannister Series.)
Helpet Edge Rock
Bullion Coal
Bullions containing *Goniatites* and many marine shells.
Gannister or Mountain Mine
Marine band also about this horizon. *Carbonicola subconstricta* and *C. acuta.*
Lower Foot Mine
Carbonicola, sp., rarely.
Lower Yard Mine
Woodhead Hill Rock
First Coal
Millstone Grit
Carbonicola acuta, C., sp., and *Naiadites* occur in shale over the First Coal, Holcombe Brook Series (Bolton).
Gannister Series.

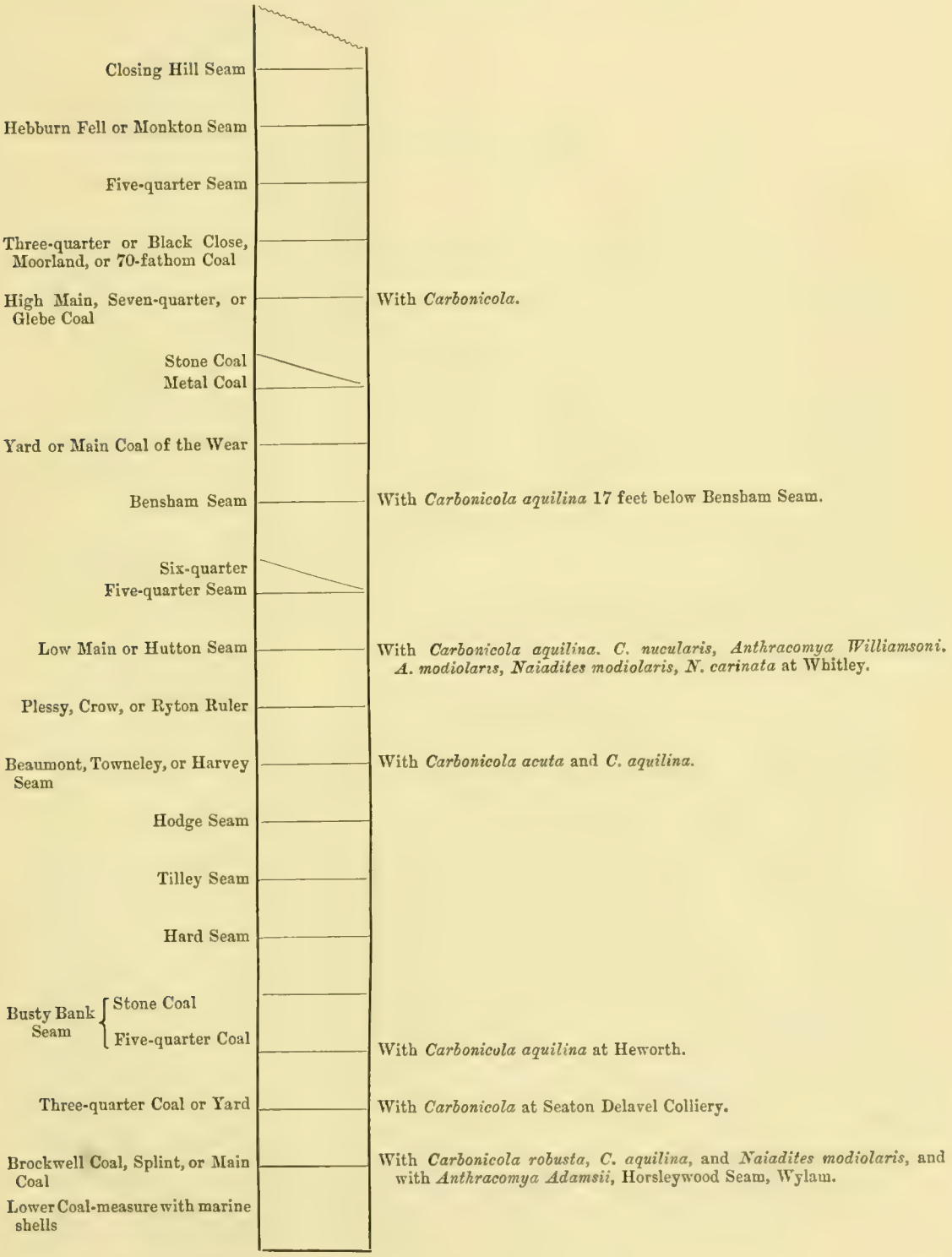
10. Yorkshire Coal-Measures—General Section.


Red Beds
Wickersley, Houghton Common, and Pontefract Rocks
Dalton, Brierly, and Ackworth Rocks
Shafton or Nostel Coal
Upper Chevel Rock
Shurlstone, Top, Low, and Yard Coals
Hollywell Wood Coals
Houghton Rock
Houghton Coals
Wheatworth Coal
Bateson's Bed
Castleford 4-foot
With Carbonicola, p. 468.*
Trecton Rocks
Newhill or Steam Coal
Swinton Pottery Coal
Woolley Edge Rock
Aston Common, Wathwood, Woodmoor, and Wakefield Muck Coals
With Carbonicola above the Wathwood seam, E. of Rawmarsh, p. 414,* and with Carbonicola above and below the Wakefield Muck at Westgate Goods-station, Wakefield, p. 768.*
Foxearth
2-ft. Coal
Cat Coal
Abdy or Winter Coal
Stanley Shale Coal
Sough or Yard
Beamshaw
Stanley Main Coal
With Carbonicola robusta, C. aquilina, C. turgida, Anthracomya Wardi, Naiadites modiolaris, N. triangularis, N. carinata at Wakefield.
Furnace Coal
With Carbonicola acuta, C. aquilina at Wakefield.
Kents thin Coal
High Hazels, Kents Thick, and Mapplewell Coals
Barnsley Rider Coal and Rock
Barnsley, Warrenhouse, and Gawthorpe Coals
Swallow-wood, Netherton, and Haighmoor Coals
With Carbonicola about the horizon of the Swallow-wood Coal, N.E. of Hall Carr Lane, Don Valley, p. 335.*
Joan, Mitchell, or Parson's Coal
Tankersley Ironstone
Mussel-bed full of Carbonicola, Anthracomya, and Naiadites, p. 325.*
Heward, Flockton thick, and Adwalton Stone Ore
With Carbonicola at Hoyland Bank Wood, p. 320, and at Lockwood Lane, N. of Emley Moor, p. 331;* at Albion Brick Works, Newton Colliery, p. 654, and at Doles Wood, p. 686.* Carbonicola turgida in abundance.
Flockton Thin Coal
Adwalton Black Bed
Middleton High Main
Fenton's Coal and Black Mine Ironstone
The Black Mine Ironstone contains Carbonicola at New Hogg's Pit, N.E. of Chapeltown Station, p. 305.*
Silkstone Group.
Park Gate, Old Hards, 2-yards, Brown Metal, and Firth Field Coals
Walter's or Thorncliffe Thin, Green Lane, Middleton little, and Hardband Coals
Carbonicola and Spirorbis about the horizon of Thorncliffe Thin Coal at Mill Houses, N.E. of Cawthorne, p. 274.*
Swilley, New Hards, and Middleton Main Coals
Large Carbonicola † near Silkstone Station (p. 256).*
Silkstone 4 feet, Wheatley Lime, ¾, and Middleton 11 yards
With Carbonicola, p. 250.*
Claywood Ironstone
Fullhouse rock
Silkstone, Blocking, and Barcelona Coals
Whin Moor group of Coals
Beeston Coal
Crow Coal
Peniston Flags
Low Moor Ironstone
With Carbonicola subconstricta at Low Moor.
Grenoside Sandstone, Coal, and Stone
Black Bed
Better Bed
Underclay and thin Coal
Gannister or Hard-bed Coal
With Goniatites and Aviculopecten, p. 108.*
Clay or Middle-bed Coal
With Carbonicola, p. 104.* Coal pit, Pit Lane, E. of Spink House, Midhopestones.
Coking or Soft-bed Coal
Marine fossils.
Black Slate
Thin Coal
With Carbonicola robusta and C. acuta. Shown at Cockshutt Lane to be in separate beds, pp. 85, 88.*
Rough Rock.

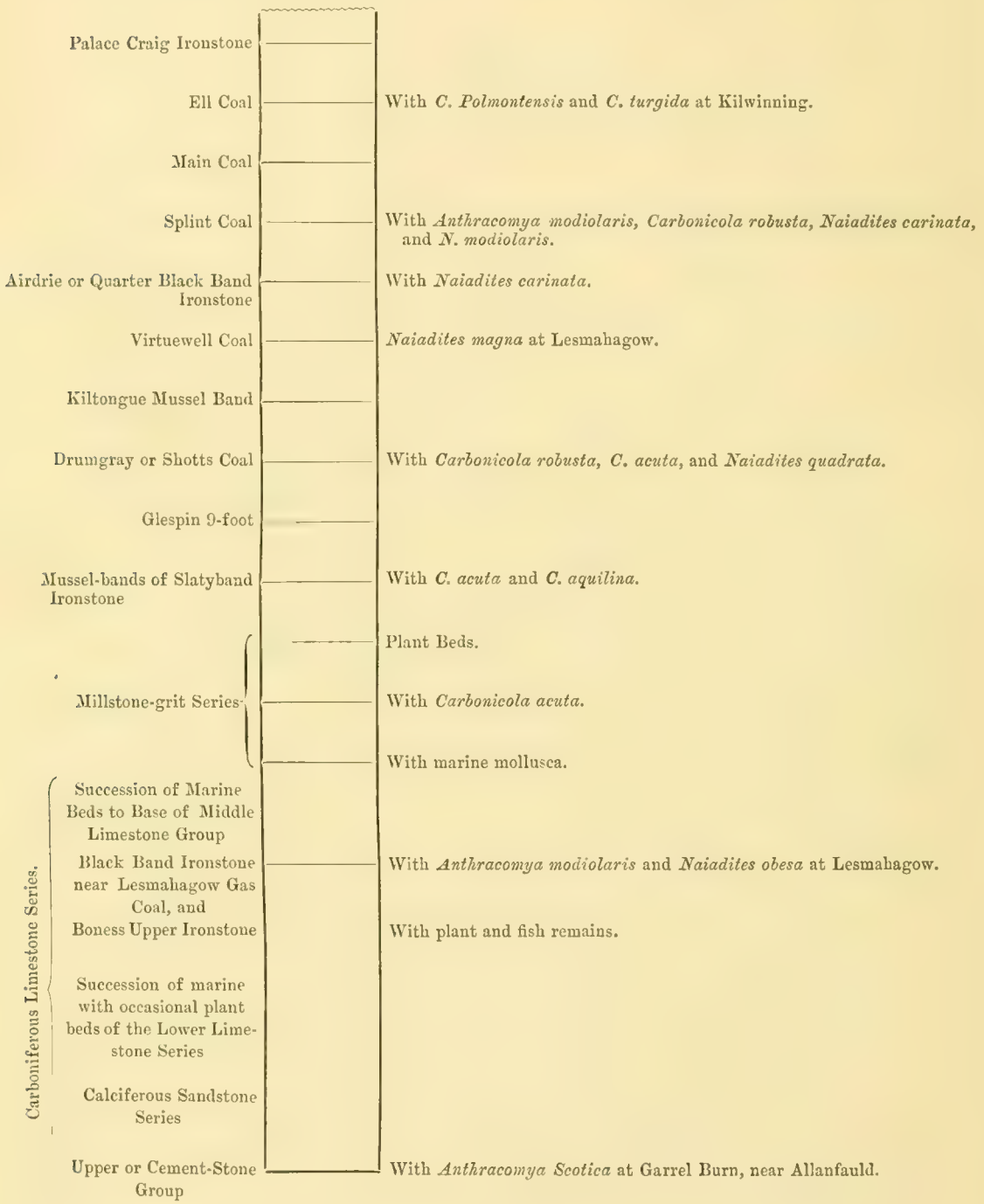
Black shale over the Coal at Beacon Hill, Halifax, contains *C. robusta*, *C. acuta*, and *C. aquilina*.

* The numbers refer to pages in the "Geology of the Yorkshire Coal-field," 'Mem. of the Geol. Survey.'
† Probably *C. robusta*, as the Silkstone of Yorkshire is supposed to be the equivalent of the Arley Mine of Lancashire, of which bed this species is typical.

11. Northumberland and Durham Coal-field.

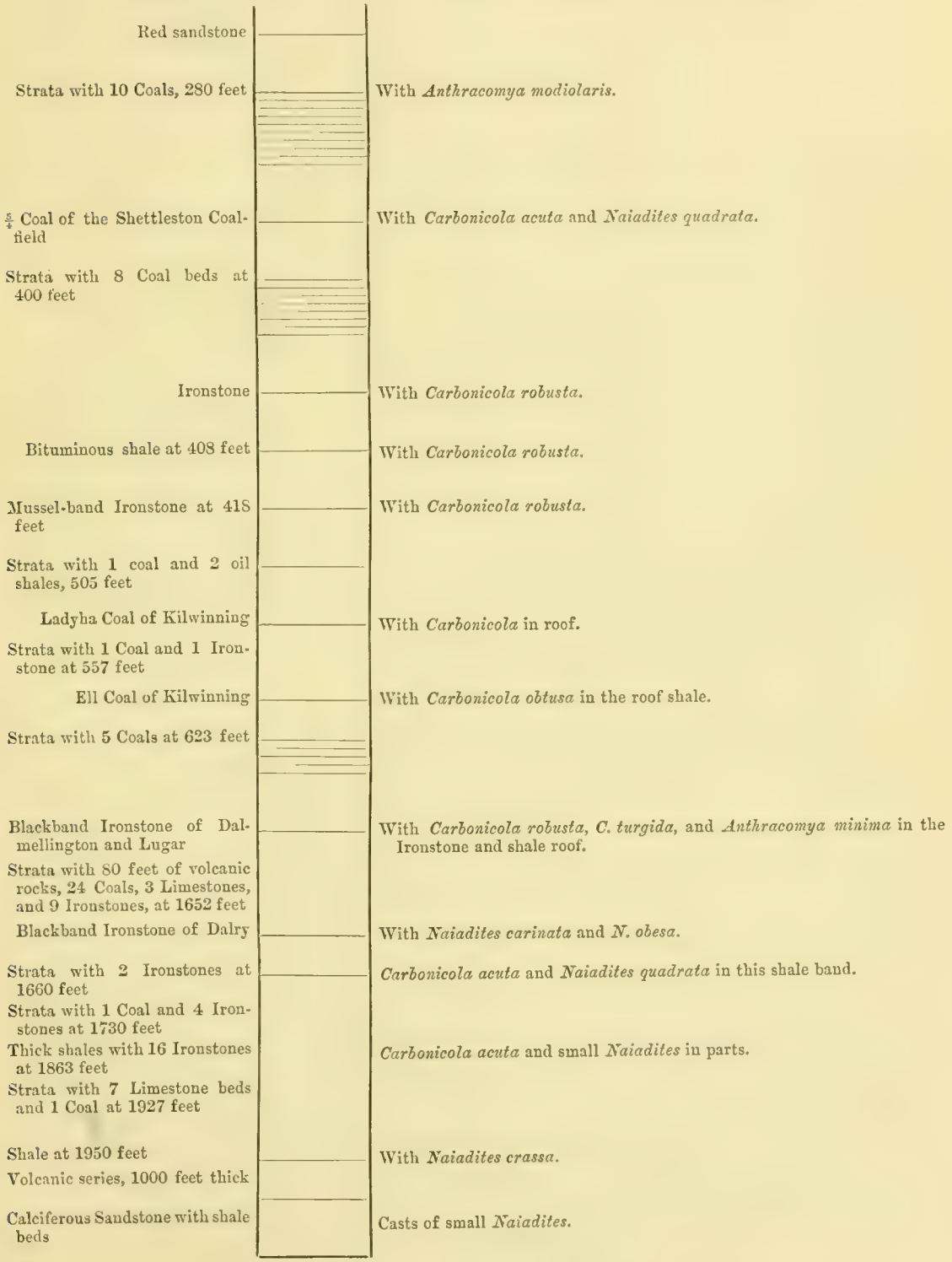

Closing Hill Seam
Hebburn Fell or Monkton Seam
Five-quarter Seam
Three-quarter or Black Close, Moorland, or 70-fathom Coal
High Main, Seven-quarter, or Glebe Coal
With Carbonicola.
Stone Coal
Metal Coal
Yard or Main Coal of the Wear
Bensham Seam
With Carbonicola aquilina 17 feet below Bensham Seam.
Six-quarter
Five-quarter Seam
Low Main or Hutton Seam
With Carbonicola aquilina. C. nucularis, Anthracomya Williamsoni. A. modiolaris, Naiadites modiolaris, N. carinata at Whitley.
Plessy, Crow, or Ryton Ruler
Beaumont, Towneley, or Harvey Seam
With Carbonicola acuta and C. aquilina.
Hodge Seam
Tilley Seam
Hard Seam
Busty Bank Seam
Stone Coal
Five-quarter Coal
With Carbonicola aquilina at Heworth.
Three-quarter Coal or Yard
With Carbonicola at Seaton Delavel Colliery.
Brockwell Coal, Splint, or Main Coal
With Carbonicola robusta, C. aquilina, and Naiadites modiolaris, and with Anthracomya Adamsii, Horsleywood Seam, Wylam.
Lower Coal-measure with marine shells

12. Succession of Strata—Lanarkshire and West of Scotland.

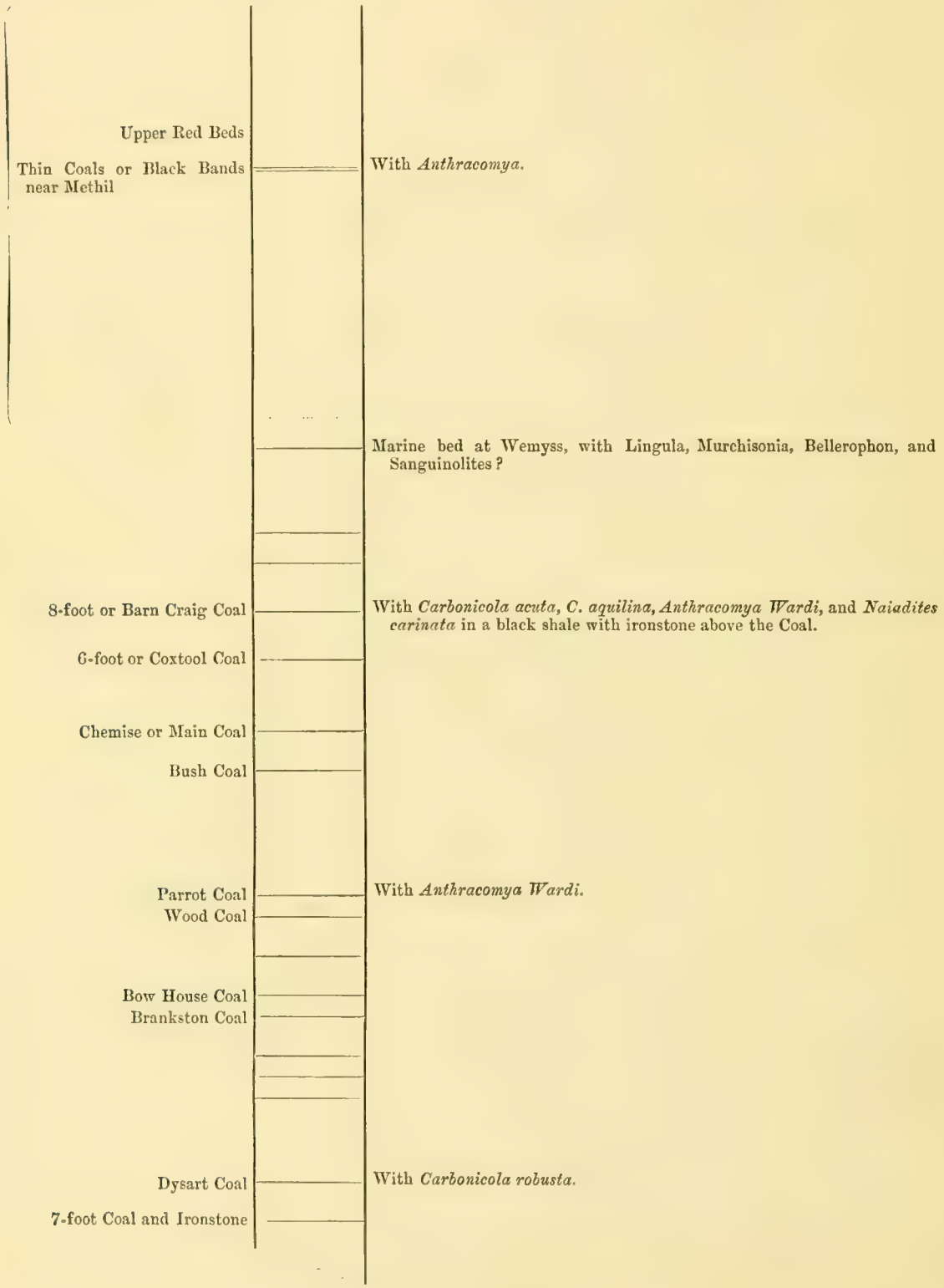

Palace Craig Ironstone
Ell Coal
With C. Polmontensis and C. turgida at Kilwinning.
Main Coal
Splint Coal
With Anthracomya modiolaris, Carbonicola robusta, Naiadites carinata, and N. modiolaris.
Airdrie or Quarter Black Band Ironstone
With Naiadites carinata.
Virtuewell Coal
Naiadites magna at Lesmahagow.
Kiltongue Mussel Band
Drumgray or Shotts Coal
With Carbonicola robusta, C. acuta, and Naiadites quadrata.
Glespin 9-foot
Mussel-bands of Slatyband Ironstone
With C. acuta and C. aquilina.
Plant Beds.
Millstone-grit Series
With Carbonicola acuta.
With marine mollusca.
Carboniferous Limestone Series.
Succession of Marine Beds to Base of Middle Limestone Group
Black Band Ironstone near Lesmahagow Gas Coal, and Boness Upper Ironstone
With Anthracomya modiolaris and Naiadites obesa at Lesmahagow.
With plant and fish remains.
Succession of marine with occasional plant beds of the Lower Limestone Series
Calciferous Sandstone Series
Upper or Cement-Stone Group
With Anthracomya Scotica at Garrel Burn, near Allanfauld.

13. Generalised Section of the Ayrshire Coal-field, showing Position of Mussel Bands.

Kindly drawn up for me by Mr. J. Smith, of Kilwinning.

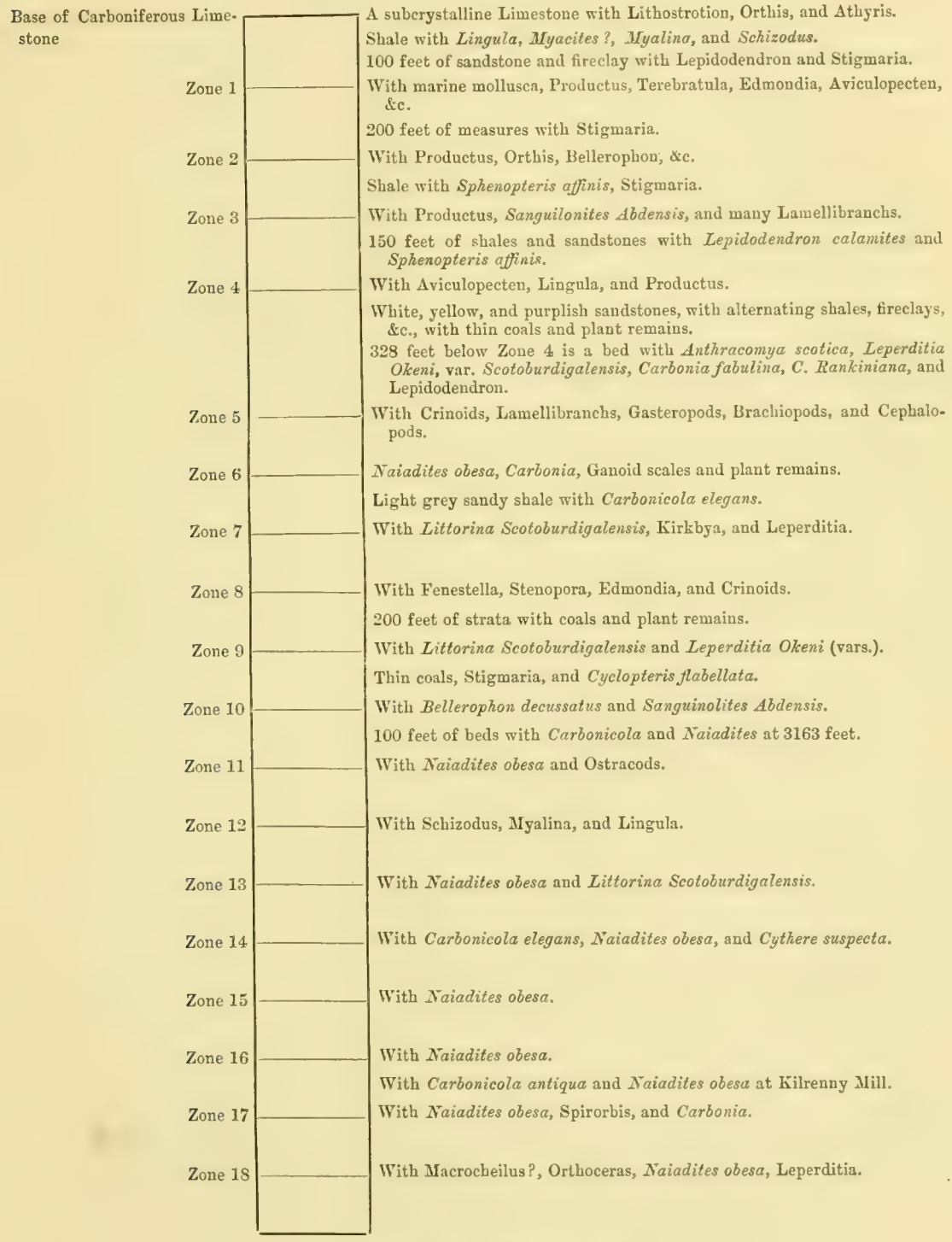

Red sandstone
Strata with 10 Coals, 280 feet
With *Anthracomya modiolaris.*
¾ Coal of the Shettleston Coal-field
With *Carbonicola acuta* and *Naiadites quadrata.*
Strata with 8 Coal beds at 400 feet
Ironstone
With *Carbonicola robusta.*
Bituminous shale at 408 feet
With *Carbonicola robusta.*
Mussel-band Ironstone at 418 feet
With *Carbonicola robusta.*
Strata with 1 coal and 2 oil shales, 505 feet
Ladyha Coal of Kilwinning
With *Carbonicola* in roof.
Strata with 1 Coal and 1 Ironstone at 557 feet
Ell Coal of Kilwinning
With *Carbonicola obtusa* in the roof shale.
Strata with 5 Coals at 623 feet
Blackband Ironstone of Dalmellington and Lugar
With *Carbonicola robusta, C. turgida,* and *Anthracomya minima* in the Ironstone and shale roof.
Strata with 80 feet of volcanic rocks, 24 Coals, 3 Limestones, and 9 Ironstones, at 1652 feet
Blackband Ironstone of Dalry
With *Naiadites carinata* and *N. obesa.*
Strata with 2 Ironstones at 1660 feet
Carbonicola acuta and *Naiadites quadrata* in this shale band.
Strata with 1 Coal and 4 Ironstones at 1730 feet
Thick shales with 16 Ironstones at 1863 feet
Carbonicola acuta and small *Naiadites* in parts.
Strata with 7 Limestone beds and 1 Coal at 1927 feet
Shale at 1950 feet
With *Naiadites crassa.*
Volcanic series, 1000 feet thick
Calciferous Sandstone with shale beds
Casts of small *Naiadites.*

14. Vertical Section of the Fifeshire Coal-Measures (300 feet at the top omitted). Scale, 1 inch to 300 feet. By kind permission of Mr. James W. Kirkby.


Upper Red Beds
Thin Coals or Black Bands near Methil
With *Anthracomya*.
Marine bed at Wemyss, with Lingula, Murchisonia, Bellerophon, and Sanguinolites?
8-foot or Barn Craig Coal
With *Carbonicola acuta*, *C. aquilina*, *Anthracomya Wardi*, and *Naiadites carinata* in a black shale with ironstone above the Coal.
6-foot or Coxtool Coal
Chemise or Main Coal
Bush Coal
Parrot Coal
With *Anthracomya Wardi*.
Wood Coal
Bow House Coal
Brankston Coal
Dysart Coal
With *Carbonicola robusta*.
7-foot Coal and Ironstone

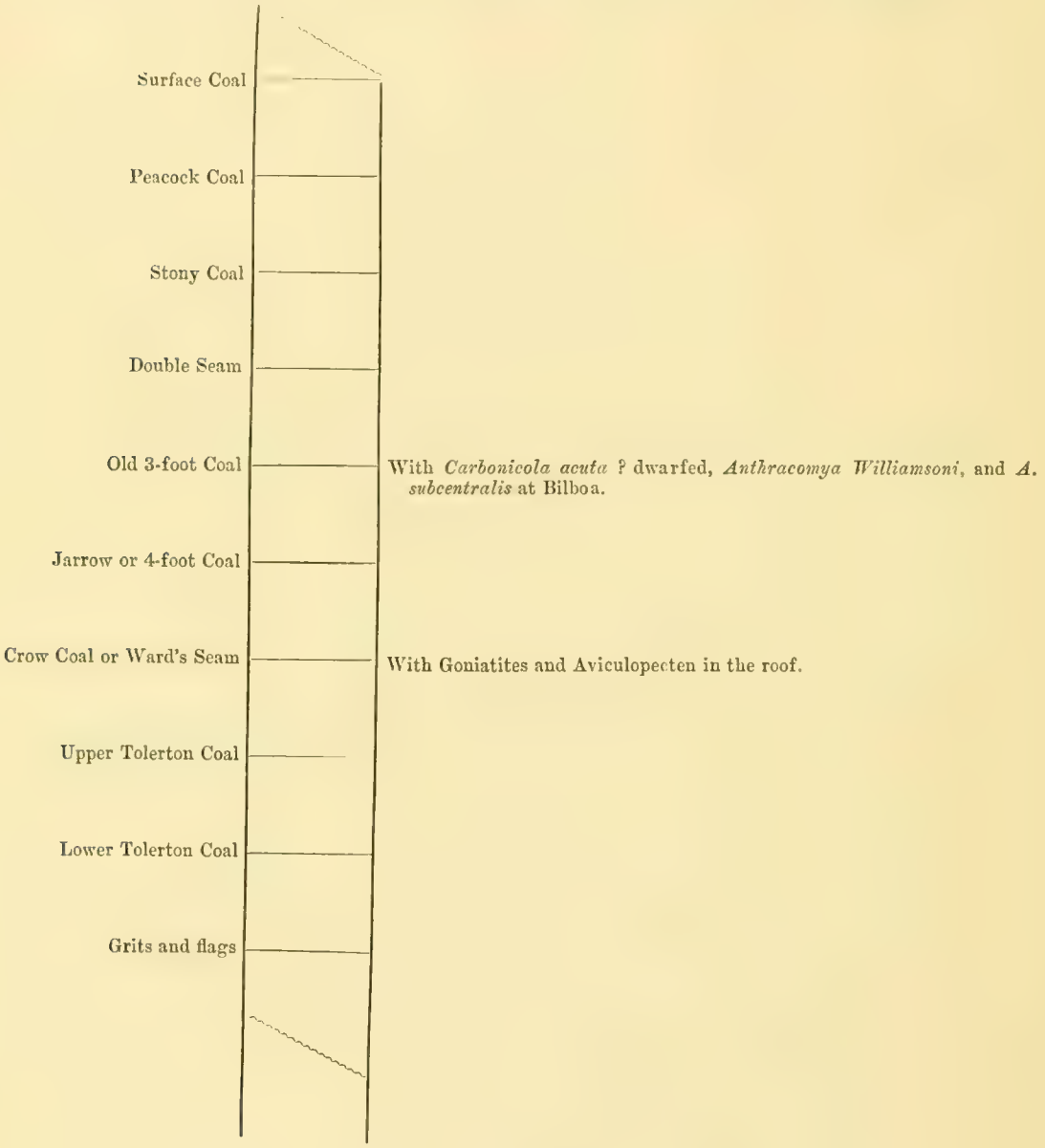
15. Diagrammatic Vertical Section of the Calciferous Sandstone of the Fifeshire Coast. Scale, 666 feet to 1 inch.

By the kind permission of Mr. James W. Kirkby (see also 'Quart. Journ. Geol. Soc.,' vol. xxxvi, 1880, p. 571).

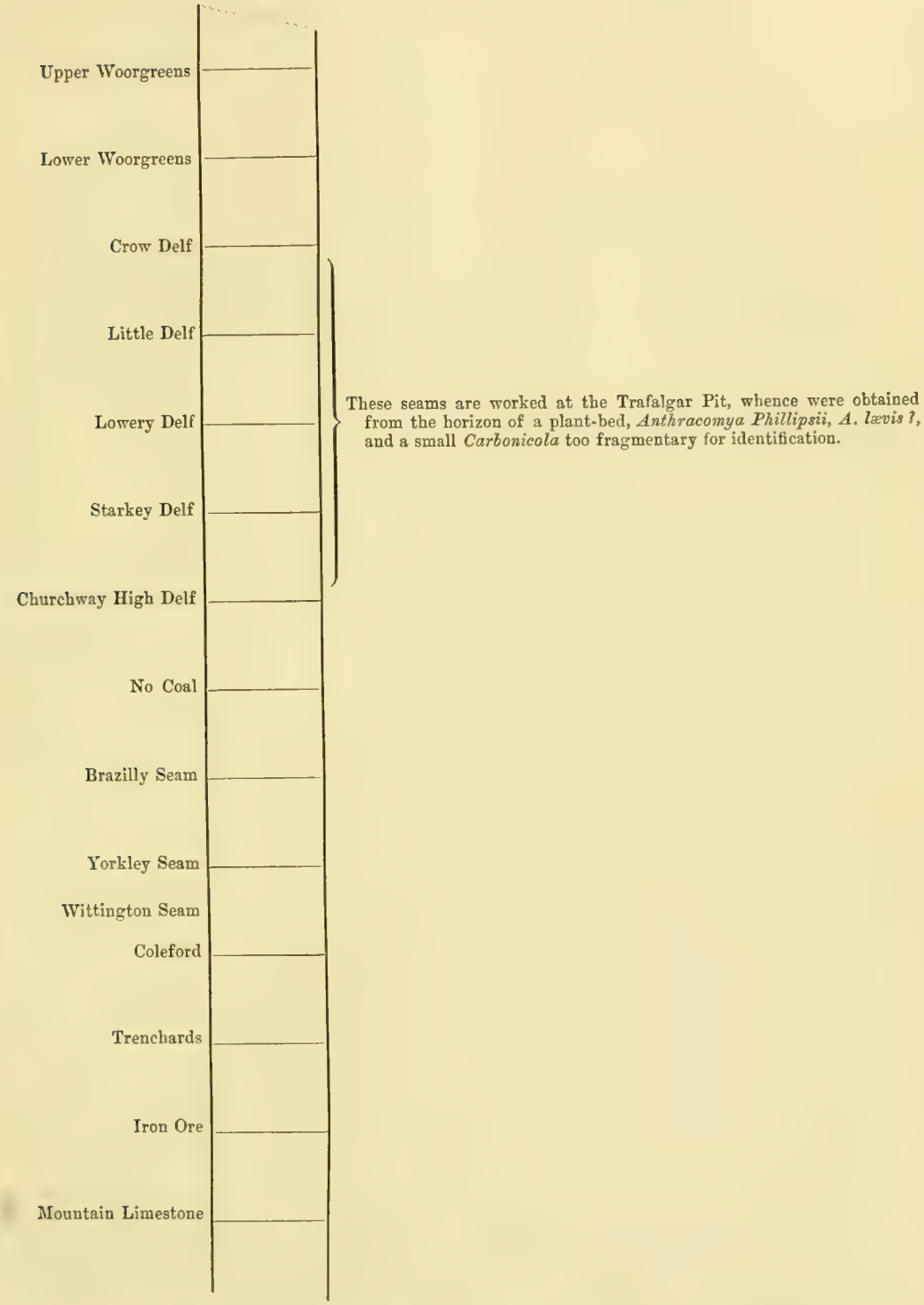

Base of Carboniferous Limestone
A subcrystalline Limestone with Lithostrotion, Orthis, and Athyris.
Shale with Lingula, Myacites ?, Myalina, and Schizodus.
100 feet of sandstone and fireclay with Lepidodendron and Stigmaria.
Zone 1
With marine mollusca, Productus, Terebratula, Edmondia, Aviculopecten, &c.
200 feet of measures with Stigmaria.
Zone 2
With Productus, Orthis, Bellerophon, &c.
Shale with Sphenopteris affinis, Stigmaria.
Zone 3
With Productus, Sanguilonites Abdensis, and many Lamellibranchs.
150 feet of shales and sandstones with Lepidodendron calamites and Sphenopteris affinis.
Zone 4
With Aviculopecten, Lingula, and Productus.
White, yellow, and purplish sandstones, with alternating shales, fireclays, &c., with thin coals and plant remains.
328 feet below Zone 4 is a bed with Anthracomya scotica, Leperditia Okeni, var. Scotoburdigalensis, Carbonia fabulina, C. Rankiniana, and Lepidodendron.
Zone 5
With Crinoids, Lamellibranchs, Gasteropods, Brachiopods, and Cephalopods.
Zone 6
Naiadites obesa, Carbonia, Ganoid scales and plant remains.
Light grey sandy shale with Carbonicola elegans.
Zone 7
With Littorina Scotoburdigalensis, Kirkbya, and Leperditia.
Zone 8
With Fenestella, Stenopora, Edmondia, and Crinoids.
200 feet of strata with coals and plant remains.
Zone 9
With Littorina Scotoburdigalensis and Leperditia Okeni (vars.).
Thin coals, Stigmaria, and Cyclopteris flabellata.
Zone 10
With Bellerophon decussatus and Sanguinolites Abdensis.
100 feet of beds with Carbonicola and Naiadites at 3163 feet.
Zone 11
With Naiadites obesa and Ostracods.
Zone 12
With Schizodus, Myalina, and Lingula.
Zone 13
With Naiadites obesa and Littorina Scotoburdigalensis.
Zone 14
With Carbonicola elegans, Naiadites obesa, and Cythere suspecta.
Zone 15
With Naiadites obesa.
Zone 16
With Naiadites obesa.
With Carbonicola antiqua and Naiadites obesa at Kilrenny Mill.
Zone 17
With Naiadites obesa, Spirorbis, and Carbonia.
Zone 18
With Macrocheilus?, Orthoceras, Naiadites obesa, Leperditia.

Zones 6 to 18 = zone of *Naiadites obesa*.

16. General Section of the Kilkenny Coal-field at Castlecomer.


Surface Coal
Peacock Coal
Stony Coal
Double Seam
Old 3-foot Coal
With *Carbonicola acuta* ? dwarfed, *Anthracomya Williamsoni*, and *A. subcentralis* at Bilboa.
Jarrow or 4-foot Coal
Crow Coal or Ward's Seam
With Goniatites and Aviculopecten in the roof.
Upper Tolerton Coal
Lower Tolerton Coal
Grits and flags

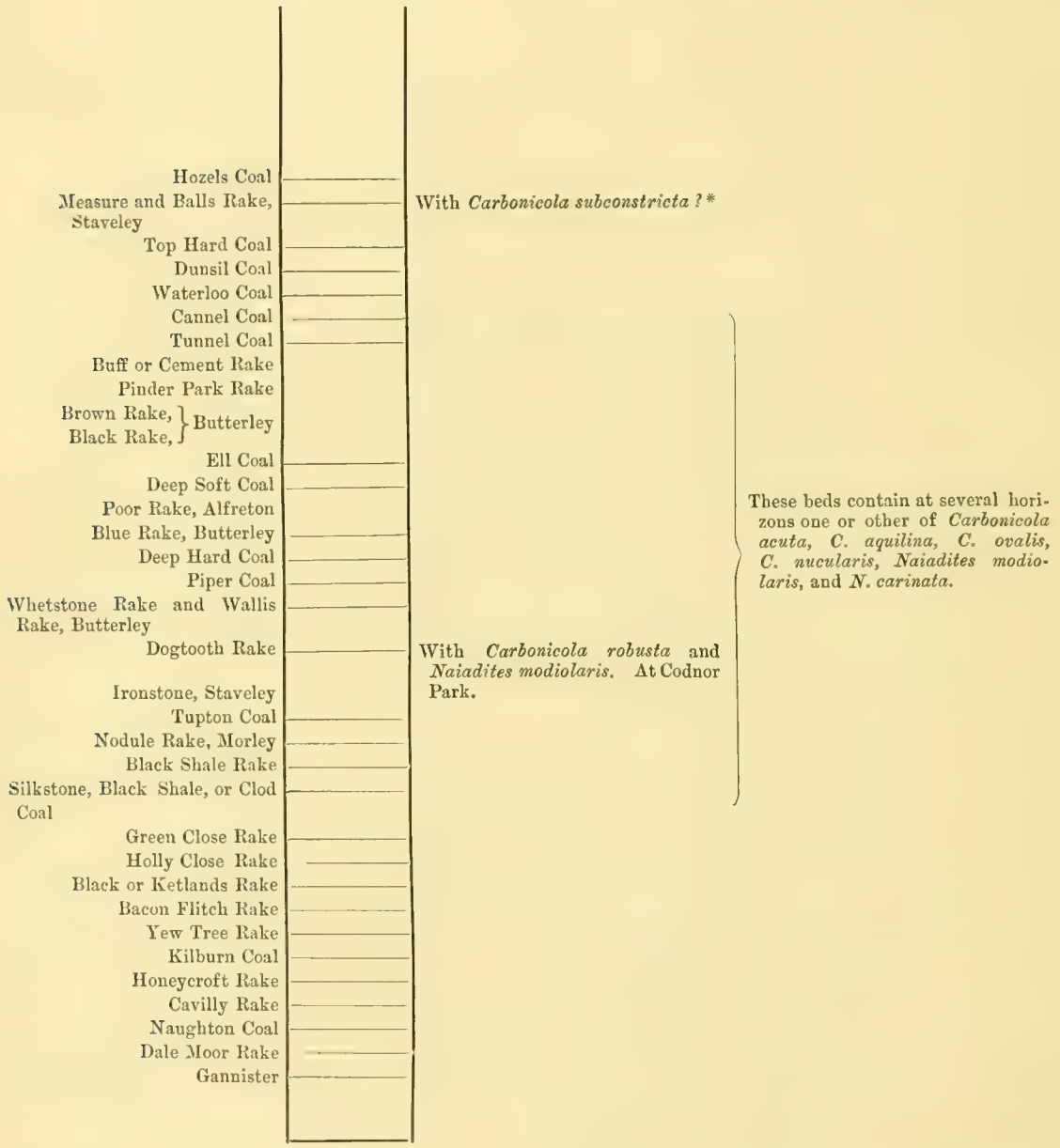
17. Section of the Forest-of-Dean Coal-field.*



* From a paper by Mr. H. D. Hoskold, 'Proc. Cotteswold Nat. Field Club,' vol. x, p. 123, 1891.

General Section of the Derbyshire Coal-field.

From Mr. A. H. Stokes' Section.



* In the 'Memoirs of the Geol. Survey of Great Britain,' "The Iron Ores of Great Britain," part i, p. 40, is stated, "This shell, Unio or Anthracosia, probably of several species, is found more or less abundantly in all the Ironstone beds, from the top of the section down to the Black Shale Rake. In the lower measures it is much more scarce, or is even altogether wanting in some of the very lowest. The *Anthracosia bipennis* which occurs in the Measure and Balls Rake is found also in the Low Moor Ironstone, and at Mold in Flintshire."

THE

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MDCCCXCVI.

A MONOGRAPH

ON

CARBONICOLA, ANTHRACOMYA, AND NAIADITES.

BY

WHEELTON HIND, M.D., B.S.Lond., F.R.C.S., F.G.S.

PART III.

APPENDIX AND INDEX,

Pages 171—182; Plate XXI.

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1896.

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19.—Section by Mr. J. Bennie of the Series at Dalmeny Shore.

Sandstone.

White trap in black shale.

Flinty limestone.

Bituminous shale.

Hard shale with Lepidodendrons and fish scales.

Beds with ironstone and calcareous nodules.

Shales with periostracum of *Naiadites?* and *Sphenopteris*.

Rocks with plant remains.

Burdiehouse limestone.

Black shale.

Black shale with ironstone bands and Cyprid beds, *Anthracomya Adamsii*.

Black shale with plants.

Soft clayey shale with *Naiadites obesa*.

Sandy beds with same shell and plants.

Bituminous shales with same.

I am greatly indebted to many fellow-workers in this field of Palæontology, to whom I wish to render my sincere thanks. Especially to Professors Dewalque, J. Fraipont, and M. Lohest of Liége, Prof. Geinitz of Dresden, Dr. Otto Jaekel of Berlin, and to Mons. L. Dollo of Brussels, who kindly assisted me to study the series of Coal-measure fossils in the respective Museums to which they are attached.

I also have to thank Dr. H. Woodward, Professor McKenny Hughes, Mr. J. W. Carr of Nottingham, Dr. John Young of the Hunterian Museum, Glasgow, Messrs. Crowther of Leeds, Howse of Newcastle-on-Tyne, Platnauer of York, W. Carr of Cardiff, H. Woods of the Woodwardian Museum, Hoyle of Owens College, and Crowther of Derby, for kind permission to study all the material in the various museums under their care, and for the loan of specimens for the purposes of figuring.

Also to Messrs. J. W. Kirkby of Leven, Dr. J. R. S. Hunter of Braidwood, J. Neilson and J. Beveridge of Glasgow, J. Smith of Kilwinning, R. Kidston of Stirling, James Bennie of the Scotch Geol. Survey, R. Craig of Beith, Joseph Wright of Belfast, Wm. Madeley of Dudley, George Wild of Bardsley, C. Roeder of Manchester, G. Campbell of Wakefield, Wm. Pickup of Rushton Colliery, Johnson of Dudley, and John Ward of Longton for the loan of large collections, and for many details as to distribution.

Also to Sir A. Geikie, Director-General, and Messrs. E. T. Newton, De Rance, Goodchild, and Nolan, of the Geological Survey of Great Britain and Ireland, for great assistance in the loan of type specimens from the Survey Museums of London, Edinburgh, and Dublin, and for valuable information on many points. Also I have to thank Mr. F. R. C. Reed, of Cambridge, for kindly showing me the Woodwardian Collections on two occasions, and Mr. Bolton, of Owens College, Manchester, for his kindness in giving up to me a work which he had already begun, and for looking over proofs for me; and Mr. William Rupert Jones, who kindly verified references and made several bibliographical researches for me.

I owe a special debt of gratitude to the Rev. Prof. Thomas Wiltshire and Prof. T. Rupert Jones for many valuable suggestions and much help.

APPENDIX.

Bibliography.

1853. In a paper "On the Coal-measures of the South Joggins, Nova Scotia," Sir W. J. Dawson at p. 39 figures two shells as Modiolæ (figs. 22 and 23), and two as Uniones (figs. 24 and 25), from these measures. No specific names.

1862. Winchell described, in the volume of the 'Proceedings of the Academy of Natural Science of Philadelphia' for 1862, p. 413, *Cardinia complanata*, *C. æquimarginalis*, said to be closely allied to *C. robusta*, and *C. concentrica*, from Carboniferous beds of the Marshall and Huron groups of Michigan.

1864–5. Messrs. Meek and Worthen ("Palæontology of the Upper Missouri," part i, p. 34, 'Smithsonian Contributions to Knowledge,' No. 172) include Carbonicola (spelt Carbonocola) in the family Crassitellidæ, with Astarte, Crassatella, Cardita, &c., and a very large number of fossil genera of most diverse characters,—Venericardia, Pachydomus, Astartila, Astartella, Cardinia, Hippopodium, Pleurophorus, and various others.

At p. 36. Anthracomya is included in the family Anatinidæ, with Anatina, Thracia, Pandora, and Pholadomya, and other recent genera, and with the fossil genera Carcomya, Allorisma, Myciates, Arcomya, Cardiomorpha, Sedgwickia, Sanguinolites, and others. Such a group, with scarcely a character in common, cannot be admitted for a moment.

1875. Baily gives a figure of *Carbonicola ovalis* under the name *Anthracosia centralis* in his 'Figures of Characteristic British Fossils,' p. 115, pl. xxxix, fig. 5, from the Coal-measures of Wednesbury, South Staffordshire.

1878. Bigsby's 'Thesaurus Devonico-Carboniferus' gives lists of all the then known species of Devonian and Carboniferous Lamellibranch fossils. The following are from American Carboniferous strata (p. 296) :

Anthracosia æquimarginalis,[1] Winchell.	*Anthracosia concentrica*,[2] Winchell.
— *Antigonesensis*, Dawson.	— *fragilis* (?), Cox.
— *Bradorica*, Dawson.	— *nana*, Owen.

[1] This shell is referred to Edmondia by S. A. Miller.

[2] This shell is referred to Sanguinolites by S. A. Miller.

Anthracosia occidentalis, Swallow.
— *subangulata*, Dawson.
Anthracoptera carbonaria, Dawson.
Anthracoptera fragilis, Meek and Worthen.
— *lævis*, Dawson.

1889. S. A. Miller, in his work on 'North American Geology and Palæontology,' gives at p. 462 a brief definition of the genus Anthracomya, referring several of Dawson's Acadian species of Naiadites to this genus, amongst them *Naiadites carbonaria*. On p. 463 he gives short definitions of Anthracoptera and Anthracosia, referring *A. polita*, White, to the former, and *A. Bradorica* to the latter genus.

1894. A paper entitled "Revision of the Bivalve Mollusks of the Coal-formation of Nova Scotia," by Sir W. J. Dawson, was issued by the Peter-Redpath Museum. He reviews the whole question of the nomenclature of Anthracomya and Naiadites, and figures the following new species:—*Naiadites longus*, *N. mytiloides*, and *Anthracomya obtenta*. The older species are re-figured, and remarked upon at length.

1896. Holroyd and Barnes, in vol. xxiv, pt. 5, 'Transactions Manchester Geol. Soc.,' "On the Rocks and Fossils of the Yoredale Series of the Marsden and Saddleworth Valleys," note the occurrence of several species of Carbonicola in that series, amongst which I note *C. turgida*, *C. acuta* (small), and *C. aquilina*.

Additional Notes on the Species.

Carbonicola robusta (p. 45).—On p. 48 I remarked that the only specimens of this species that I had seen with eroded umbones were from Codnor Park, Derbyshire. I have since then acquired several specimens from Shotts, which show this condition remarkably well, one of which I figure, Pl. XXI, figs. 11 and 12. The name *Unio discrepans*, Brown, 1849, 'Fossil Conchology,' p. 213, pl. lxxxviii, fig. 24, should be added to the synonymy of *C. robusta*.

C. ovalis (p. 56).—To the synonymy of this species should be added *Anthracosia centralis*, Baily, 1875, 'Figures of Characteristic British Fossils,' p. 115, pl. xxxix, fig. 8.

C. obtusa (p. 61).—This shell has been found in fair abundance in a bed of black shale a few yards above the Moss Coal in sinking a new pit at Longton, North Staffordshire Coal-field. It occurs with *C. gibbosa*, *C. aquilina*, *C. acuta*, and *C. turgida*.

C. nucularis (p. 63).—This species occurs in large quantities in the "cockle-shell" bands above the Rushey Park seam, St. Helens. The shells from this locality are much larger than those found in North Staffordshire, and exhibit

much variation in form. One is figured Pl. XXI, fig. 8. It has also been found in the roof of the Bute seam, Dyllas Colliery, South Wales.

C. aquilina.—To the synonymy of this species must be added *Unio littoralis*, Brown, 1849, 'Fossil Conchology,' pl. lxxxviii, fig. 7.

The Ure Collection is, I find, preserved in the Museum of the Royal Society of Edinburgh, and the Council have kindly lent me the shell which is supposed to be Ure's "mussel," and which should therefore be the type of Fleming's *Unio Urei*. This shell, which is figured on Pl. XXI, fig. 1, is not very easy to identify, but I believe it to be a young specimen of *Carbonicola acuta*. Sowerby's shell is published in vol. i of the 'Mineral Conchology,' which is dated 1813; Fleming's 'History of British Animals' is dated 1826; therefore *Unio Urei* must be placed as a synonym of *Carbonicola acuta*, and not, as I have suggested p. 69, of *C. aquilina*. I would point out that the shell now figured differs much in size from Ure's original drawing, the latter being the representative of a much more massive and older shell.

To the localities where *Carbonicola aquilina* is obtained should be added the roof of the 4-foot seam, Bwllfa Colliery, and the roof of the 2-foot 9-inch seam, Galli, and a bed of Ironstone, Aberdare, all in the South Wales Coal-field. Also the Yoredale series of Marsden, Pule Hill.

Carbonicola similis (p. 76).—Some fine specimens of this shell have been obtained from some Ironstone measures at Aberdare, by Mr. O'Connor.

Carbonicola turgida.—To the localities for this species (p. 67) should be added the Ironstone seam of Aberdare, and Pule Hill in the Yoredale series.

Anthracomya Adamsii (p. 89).—This shell has been obtained in a bed of ironstone at Aberdeen by Mr. O'Connor, and in a bed of black shale with Ironstone band and Cyprid beds a little way below the Burdiehouse limestone on the shore at Dalmeny by Mr. James Bennie. The specimens are all crushed flat, but have the periostracum well preserved.

Anthracomya modiolaris (p. 95).—This species has been obtained by Mr. O'Connor from the roof of the 4-foot coal, Bwllfa Colliery, South Wales.

Anthracomya senex (p. 111).—A very perfect example of this species has been obtained by Mr. O'Connor from a bed of Ironstone at Aberdare; I have also obtained this species from the Lancashire Coal-field.

Anthracomya Wardi (p. 105).—Mr. O'Connor has obtained this species from the roof of the Ellad seam, Brysbach, South Wales Coal-field.

Two very fine shells obtained from the Possil Lower Black-band, in the collection of Dr. John Young, resemble very closely certain smaller shells which I figured on Pl. XIII, figs. 13, 15, and 16. All the other adult forms, and most of the young ones of this species which have come to hand, are compressed, and otherwise distorted (Pl. XV, figs. 12—16, 18, and 20). The position of the umbones and

the characteristic form of the anterior end and the subparallel margins appear to me to be typical of *A. Wardi*.

Dr. Young tells me that these are the only shells of this species known from this locality, and that he has not met with this form before. I have no hesitation in referring them to the genus Anthracomya, and to the same species as figs. 13 and 15 of Pl. XIII, although the Possil shells are so much finer than any others. Conditions must have been extremely suitable for the growth and development of the shell in this locality, and it is remarkable that no more specimens are to be met with in Scottish collections. Dr. Young informs me that crushed forms of Naiadites, probably *N. modiolaris*, occur with this shell, and that *Lingula squamiformis* also is found in bands of black shale in connection with the Possil Lower Ironstone, but that Naiadites and Lingula never occur in exactly the same stratum.

Of Dr. Young's two specimens one is very much larger than the other. The finer example (Pl. XXI, fig. 9) is, however, somewhat crushed and imperfect at the anterior end, and does not show the typical form of the shell so well as the other (Pl. XXI, fig. 10).

This shell measures—

Antero-posteriorly	66 mm.
Dorso-ventrally at umbo . . .	23 „
Laterally	15 „

Anthracomya Phillipsii (p. 120).—Pl. XXI, fig. 7, is a non-compressed example of this species from the Upper Coal-measure shales, Speedwell Pit of the Gloucestershire Coal-field. Typical compressed examples occur in the same shales.

Anthracomya dolobrata has also been obtained from the Lancashire Coal-field; two specimens, of which I figure one, fig. 13, are assuredly young.

16. Anthracomya subparallela, *Portlock*, sp., 1843. Plate XVII, figs. 1 and 2; Plate XXI, figs. 2—6.

Modiola subparallela, *Portlock*, 1843. Report Geology County Londonderry, &c., p. 433, pl. xxxiv, fig. 16.
— — *Morris*, 1843. Catalogue of British Fossils, p. 92.
? Cardinia subparallela, *Keyserling*, 1846. Petschora Land, p. 255, pl. x, fig. 15.
— — *d'Orbigny*, 1850. Prodrome de Paléontologie, p. 131.
— — *Eichwald*, 1860. Lethæa Rossica, 2nd part, p. 1007.
Modiola Macadamii, *Baily*, 1875. Figures of Characteristic British Fossils, p. 114, pl. xxxix, fig. 6.

Modiola Macadamii, *Kinahan*, 1878. Manual of the Geology of Ireland, pl. iii, fig. 4.

— subparallela, *R. Etheridge*, 1888. Fossils British Palæozoic, p. 285.

Specific Characters.—Shell moderately convex, especially in front, transversely oblong. Superior and inferior borders subparallel. The anterior end is short, convexly swollen, and has an almost semicircular margin, passing gradually below into the inferior border, which is straight, or with an almost obsolete sinuation a little anterior to its centre. The posterior border is truncate, almost straight above, rounded below. The hinge-line is straight and long. The umbones are tumid, obtuse, elevated above the hinge-line, and continuous, slightly excavated in front by a well-marked but small lunule; and are situated very anteriorly in the anterior one-sixth of the shell. The valves are convexly swollen; there is a shallow contraction which passes obliquely downward and backward from the back to the lower margin, becoming wider as it nears the lower edge of the valve, which indistinctly marks off the anterior from the posterior part of the shell. Posterior to this sulcus the shell is diagonally swollen from the umbo to the posterior inferior angle, the swelling becoming less marked as it proceeds backwards. Above the swelling the valves are flattened and compressed into the hinge-line and posterior border.

Interior.—Casts show the usual arrangement of the adductor and accessory muscle-scars.

The hinge is edentulous, and consists of a thickened mass in front, strongly connected with the shell, situated immediately below the umbo, which projects downwards, and is slightly bevelled at the expense of the upper portion, and of a smooth elongated part posteriorly bevelled at the expense of the lower margin.

Exterior.—The surface is ornamented with many very fine, thread-like striæ and lines of growth parallel to the border of the valves. Shell thin.

Dimensions.—The type-specimen, Pl. XXI, fig. 2, measures—

Antero-posteriorly	25 mm.
Dorso-ventrally	9·5 ,,
Elevation of valve	4 ,,

Distribution.—In Carboniferous shales at Ballynascreen, and Slieve Gullion, co. Derry; Clogher, co. Tyrone, and Ballycastle, co. Antrim. Lower Carboniferous shales of co. Cork and co. Tipperary (Baily).

Observations.—This shell is very distinct from those named *Modiola Macadamii* by Portlock, although he was not altogether of this opinion, for he says, "Though this appears so very distinct a form from *Modiola Macadamii*, I am disposed to think that they all merge one into the other." As a matter of fact two of the varieties of *M. Macadamii* are very distinct indeed, and all are totally different

from the shell under description. The shale in which *A. subparallela* occurs is lithologically distinct from that in which the other forms are found.

I had figured two specimens, Pl. XVII, figs. 1 and 2, from the cabinet of Mr. Joseph Wright, of Belfast, and remarked at p. 88, *ante*, that my attention had been drawn to the resemblance between this shell and those of the genus Anthracomya; and since that time I have been able to study the original specimen on which the species was founded, now preserved in the Museum of the Geological Survey, Jermyn Street, and some more specimens from Ballycastle in the Belfast Museum, two of which have the hinge exposed. This material came into my hands after the letterpress of my observations on Anthracomya was printed off, but I mentioned the fact that I had come to the conclusion that the shell really belonged to that genus in a note on the page of explanation to Pl. XVII.

I now re-figure the original type by the kind permission of Sir A. Geikie, and a specimen showing the greater part of the hinge by the permission of the authorities of the Belfast Museum. The hinge, it will be noted, differs from that of *A. modiolaris* in not possessing an elongated posterior lateral tooth, so that this character cannot be considered typical of the genus. I have not met with *A. subparallela* in the beds at Hollywood, near Belfast, where *Modiola Macadamii* occurs.

This species resembles more nearly *A. punctata* than any of the others, but is more convex, the lateral constriction is better marked, and the lines of growth are somewhat oblique to the long axis of the shell.

There is a fine slab of this species in the Geological Survey Collection at Dublin from Slieve Gullion, Derry, showing a large variety of shells in various stages of growth. In the younger shells the oblique sulcus is more marked.

Baily ('Figs. Char. Brit. Foss.,' 1875) evidently considered all the forms described by Portlock as one, for he figures *M. subparallela*, and in the text (p. 114) unites it with *Macadamii* of Portlock and its varieties.

Keyserling and Eichwald both referred specimens from Russian Carboniferous beds to Portlock's species, but altered the generic name to Cardinia.

A figure is given by Keyserling (op. sup. cit.), and this differs somewhat in contour from Portlock's type. Eichwald's description is short, and would do for *A. subparallela*.

Naiadites modiolaris (p. 131).—To the localities for this shell should be added the roof of the 2-foot 9 seam, Galli Colliery, and the roof of the 4-foot seam, Bwllfa Colliery, South Wales.

N. carinata also occurs in the latter bed.

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ERRATA.

Page 5, line 4, *for* Limestone *read* Ironstone.
„ 20, line 17, the 1st part of 'Mélanges paléontologiques' is dated 1848.
„ 20, „ 3 from bottom, *for* Bronn *read* Brown.
„ 21, to list of Coal-measure shells described in Brown's 'Fossil Conchology,' add *Unio littoralis* and *U. discrepans*.
„ 38. The line "*Class* Pelecypoda (Lamellibranchiata)" should be above (not below) the line "Asiphonidæ (Integropalliata)."
„ 58, line 19, *for* Leicester *read* Derby.
„ 63, line 11 from bottom, *for* Leicestershire *read* Derbyshire.
„ 78, line 7 from bottom, *for* Bronn *read* Brown.
„ 131, line 6 from top, *for* Rabchester *read* Ribchester.
„ 158, 3rd line from bottom, *for* bars *read* bands.
Explanation of Pl. IV, 2 lines from bottom, *for* Leicestershire *read* Derbyshire.

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PLATE I.

Fig. 1.—*Carbonicola robusta.* From Lower Yard Seam, Fulledge, Burnley. In Mr. George Wild's Collection. (Page 45.)

Fig. 2.—*Carbonicola robusta.* The original of Prof. Prestwich's figure, 'Geology of Coalbrookdale,' pl. xxxix, fig. 14, from his Collection. (Page 45.)

Fig. 2 *a*.—The same specimen viewed from superior border.

Fig. 3.—*Carbonicola robusta.* From Dalmellington, Upper Coal-measures. From Dr. Hunter's Braidwood Collection. (Page 45.)

Fig. 3 *a*.—The same, showing the external view of hinge and ligament. (Page 45.)

Fig. 4.—*Carbonicola robusta.* Dalmellington, Upper Coal-measures. Dr. John Young's Collection. (Page 45.)

Fig. 5.—*Carbonicola robusta.* Dalmellington, Upper Coal-measures. Dr. John Young's Collection. (Page 45.)

Fig. 6.—*Carbonicola robusta.* Upper Coal-measures, Dalmellington. A less transverse form from Dr. Hunter's Braidwood Collection. (Page 45.)

Fig. 6 *a*.—The same, showing the external view of the hinge and ligament. (Page 45.)

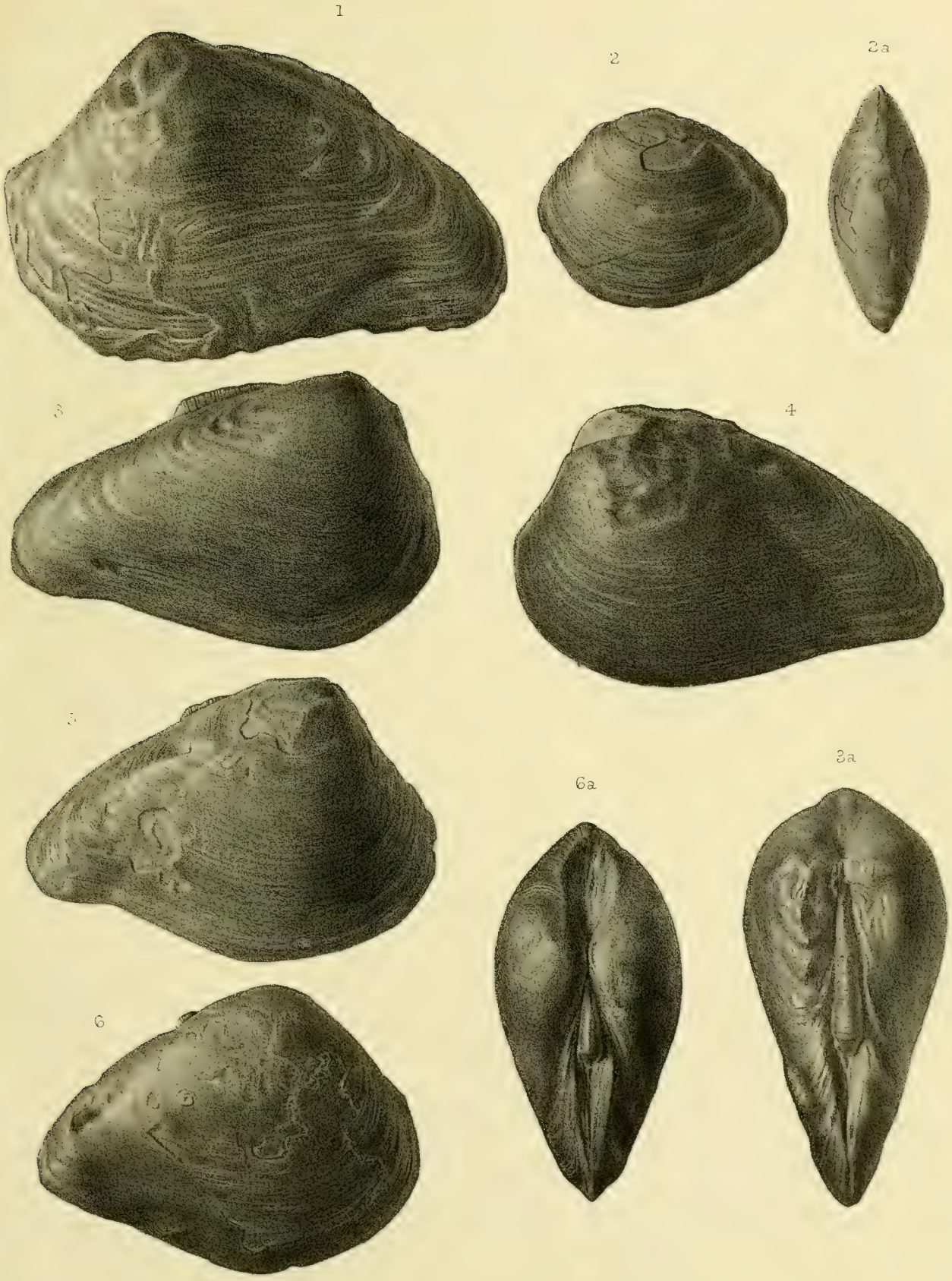

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PLATE II.

Fig. 1.—*Carbonicola robusta.* Transverse form from Limerigg Slamannan Collection of Mr. Smith of Kilwinning, Ayrshire. (Page 45.)

Fig. 1 *a.*—*Carbonicola robusta.* The same shell, showing interior and hinge of the right valve. *a.* The edentulous anterior portion of the hinge-plate. *b.* Cardinal tooth somewhat bevelled at the expense of its lower border. *c.* Concavity for cardinal tooth of the left valve. *d.* Plain toothless surface of the posterior part of the hinge-plate. The unsinuated pallial sinus and posterior adductor scar, are also shown. (Page 45.)

Fig. 2.—*Carbonicola robusta.* Small form from Shotts. Same Collection. (Page 45.)

Fig. 3.—*Carbonicola robusta.* A more rotund form from Upper Coal-measures, Airdrie. Dr. John Young's Collection. (Page 45.)

Fig. 4.—*Carbonicola robusta.* Dalmellington. Dr. Hunter's Braidwood Collection. (Page 45.)

Fig. 5.—*Carbonicola robusta.* Quadrate form from Dalmellington. Dr. Hunter's Braidwood Collection. (Page 45.)

Fig. 5 *a.*—The same, showing cast of the interior and hinge-line. (Page 45.)

Fig. 6.—*Carbonicola robusta.* Young form. Mr. Beveridge's Collection. (Page 45.)

Fig. 7.—*Carbonicola rugosa.* From Cant Clough, Burnley. Mr. George Wild's Collection. (Page 49.)

Fig. 8.—*Carbonicola rugosa.* From Hebden Bridge. Collection of the Geological Survey, Jermyn Street. (Page 49.)

Fig. 8 *a.*—The same, showing external ligament and hinge-line.

Fig. 9.—*Carbonicola robusta.* Hinge-plate of specimen from the Holly Lane Seam (?), Hanley and Bucknall Colliery, North Staffordshire. My Collection. (Page 45.)

Figs. 10 and 11.—*Carbonicola robusta.* From the Shale above Stinking Coal, Froghall. My Collection. (Page 45.)

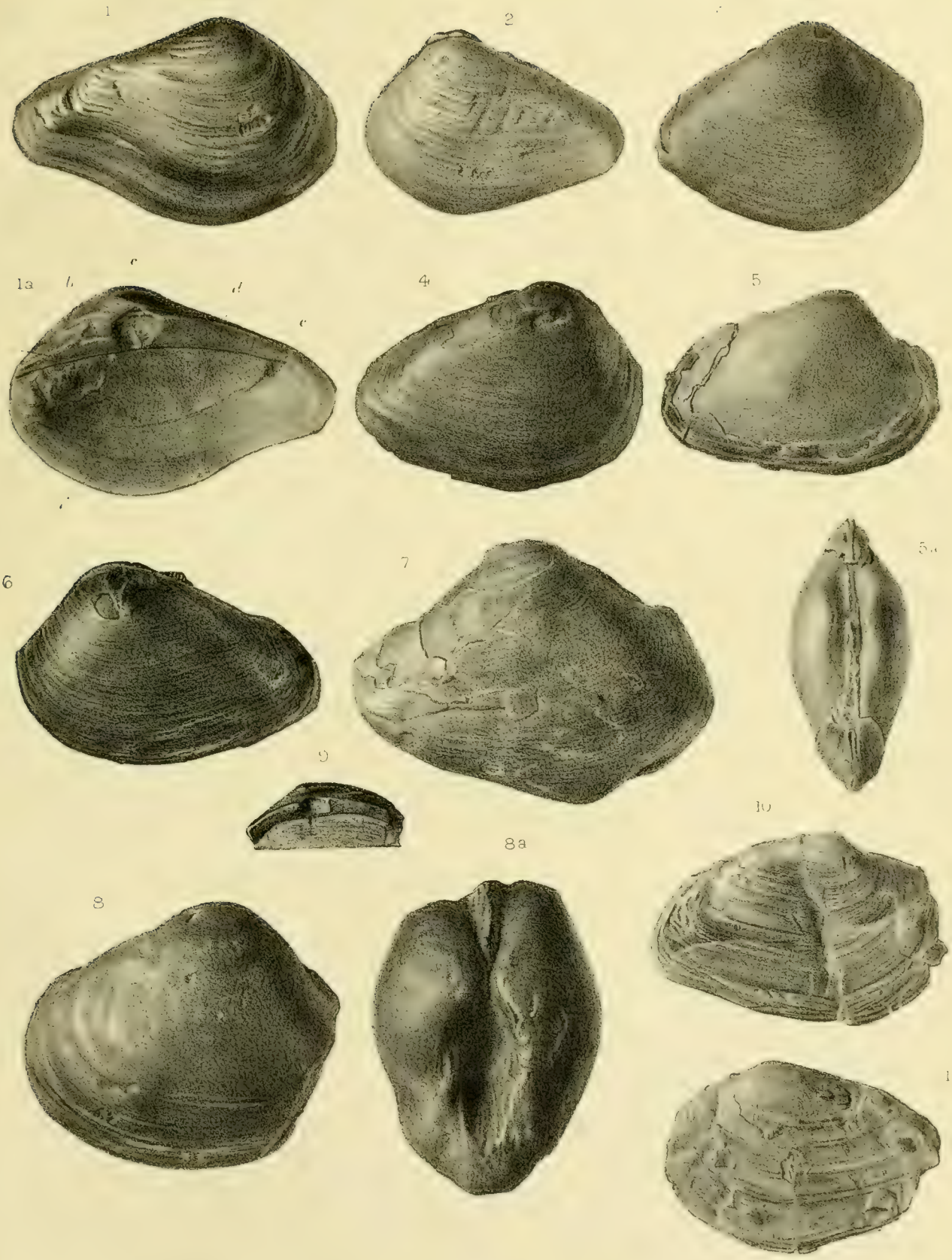

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PLATE III.

Fig. 1.—*Carbonicola acuta.* The original specimen, figured in vol. i, pl. xxxiii, fig. 6, in Sowerby's 'Mineral Conchology.' In the Sowerby Collection, Nat. Hist. Museum, South Kensington. (Page 50.)

Fig. 2.—*Carbonicola acuta?* Ditto, pl. xxxiii, fig. 5; but it is a question whether this shell should not rather be referred to *C. subconstricta.* (Page 53.)

Fig. 3.—*Carbonicola acuta?* From the original specimen figured, vol. i, pl. xxxiii, fig. 7, in Sowerby's 'Mineral Conchology.' In the Sowerby Collection of the Nat. Hist. Museum, South Kensington. (Page 54.)

Figs. 4—12.—*Carbonicola acuta.* A series from the roof of the Cockshead Coal Seam, Adderley Green, North Staffordshire, to show the variation in form and the gradual passage into *C. acuta*, var. *rhomboidalis.* My Collection. (Page 50.)

Figs. 5 *a* and 11 *a*.—*Carbonicola acuta.* Figs. 5 and 11 viewed from above, showing the lunule, the external ligament, and the bevelled edges of the hinge-plates posteriorly. (Page 50.)

Figs. 13—21.—*Carbonicola acuta*, var. *rhomboidalis.* From the roof of the Cockshead Coal, Adderley Green, North Staffordshire, all showing erosion of the umbones, an obliquity in the lines of growth to the long axis of the shell, and a marked broad, shallow, oblique constriction on the surface of the valve. My Collection. (Page 55.)

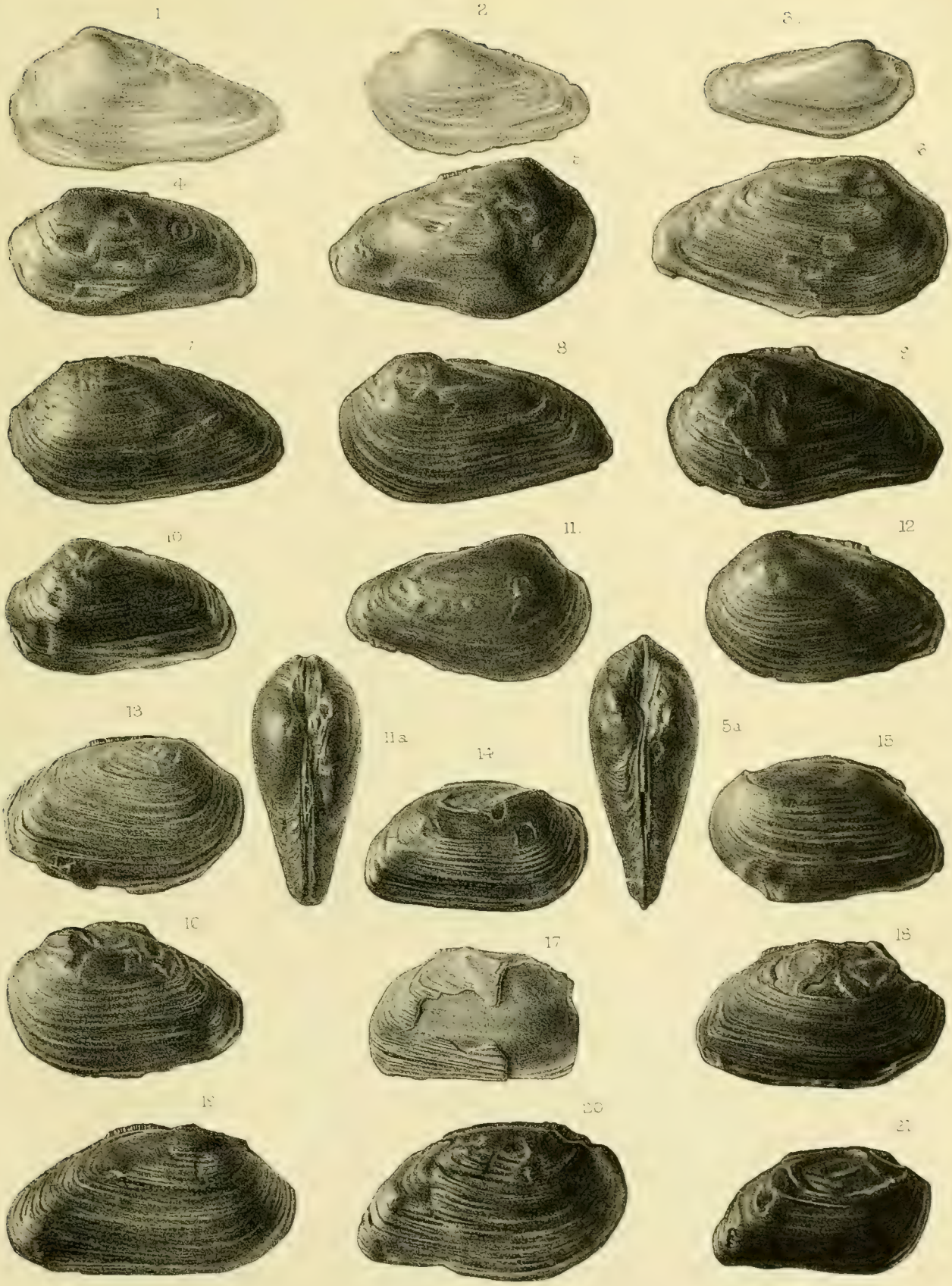

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PLATE IV.

Figs. 1—7.—*Carbonicola acuta*, var. *rhomboidalis*. Showing the passage from a truncate and obtuse posterior end to a beaked and sinuated form. From the roof of the Cockshead Seam, Adderley Green, North Staffordshire. My Collection. (Page 55.)

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Fig. 18.—*Carbonicola ovalis*. The original specimen figured by Sowerby in Prestwich's "Geology of Coalbrookdale," 'Trans. Geol. Soc.,' Ser. 2, vol. v, pl. xxxix, fig. 13. From the Pennystone beds ? Coalbrookdale. In the Collection of Professor Prestwich. (Page 56.)

Fig. 19.—*Carbonicola ovalis*. A cast of both valves from the Coal-measures of Coalbrookdale. In the Geological Collection of the Nottingham Museum. (Page 56.)

Fig. 20.—*Carbonicola ovalis*. From the Upper Coal-measures of Lanarkshire. From the Collection of Mr. J. Nielson, of Glasgow. (Page 56.)

Fig. 21.—*Carbonicola ovalis*. From the same locality and Collection. A form connecting *C. acuta* with *C. ovalis*. (Page 56.)

Fig. 22.—*Carbonicola ovalis*. From Butterley, Leicestershire. In the Geological Collection of the Nottingham Museum. (Page 56.)

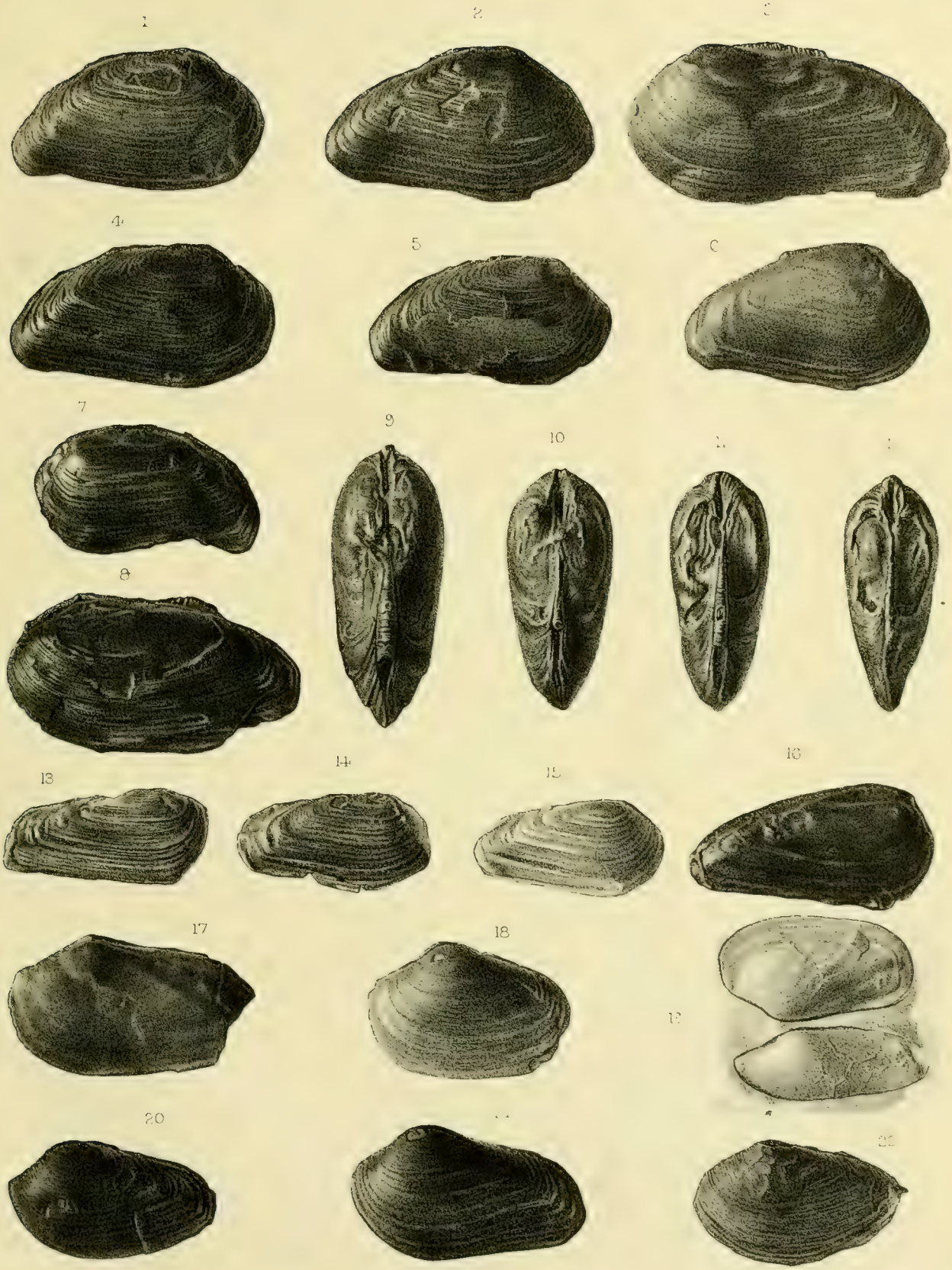
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PLATE V.

Fig. 1.—*Carbonicola acuta* (form α), showing the opposing hinge-plates of opposite valves from the Bowling Alley roof, Ivy House Colliery, Bucknall. This I regard as the normal form. My Collection. (Page 51.)

Fig. 2.—*Carbonicola aquilina*, showing the opposite hinge-plates of opposite valves. From the same locality as above. My Collection. (Page 69.)

Fig. 3.—*Carbonicola acuta* (form α). Left valve, showing hinge. Cockshead Rock, Hulme Colliery. My Collection. (Page 51.)

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Figs. 4 and 12. *Carbonicola acuta* (form α), showing the hinge, from the Ten-foot Coal, Bucknall. My Collection. (Page 51.)

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Fig. 39.—*Carbonicola acuta*. Right valve, showing a trifid cardinal tooth. Same locality. My Collection. (Page 50.)

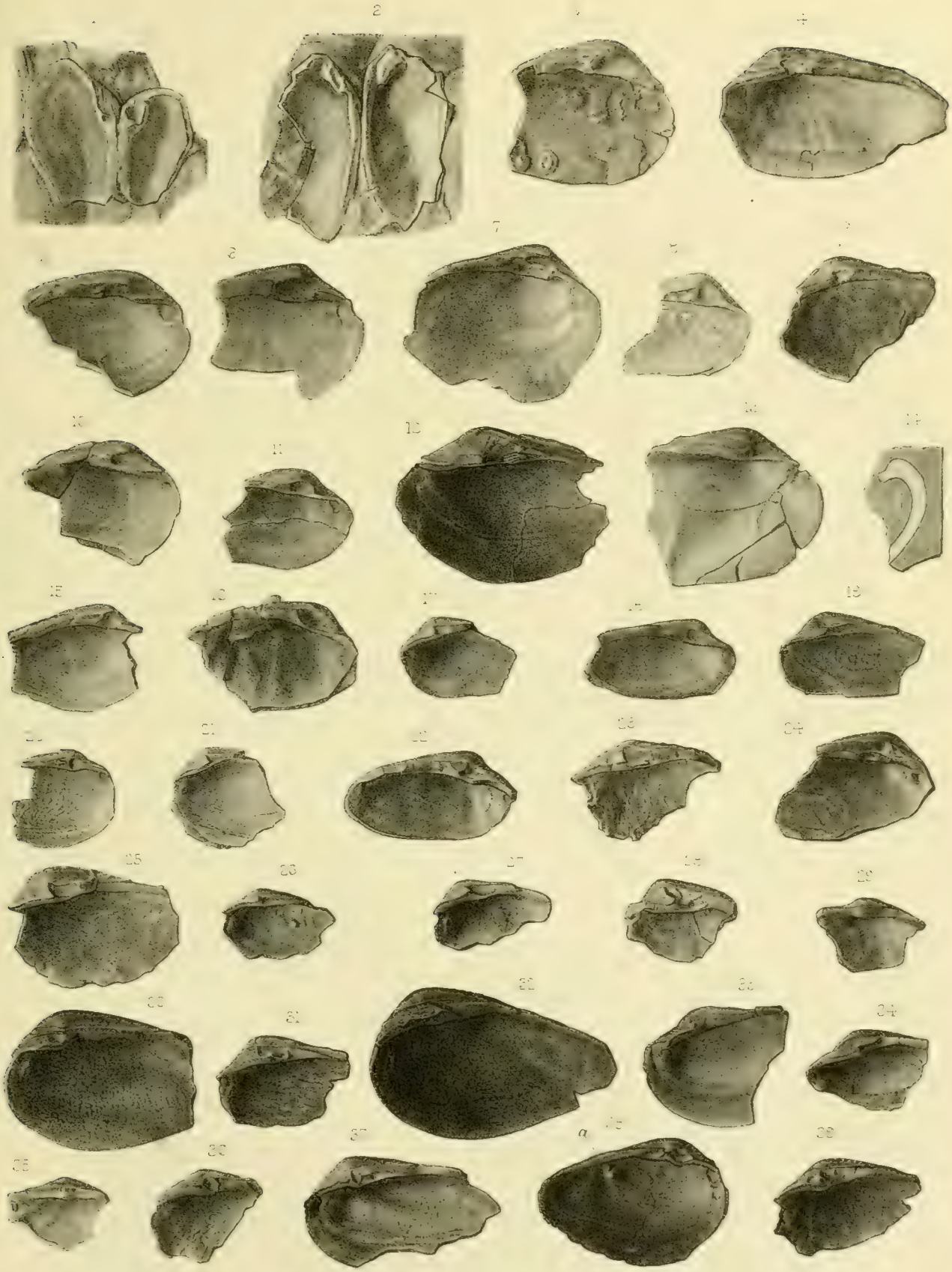

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PLATE VI.

Fig. 1.—*Carbonicola acuta.* Left valve, showing single median cardinal tooth. From the Cockshead Rock, Adderley Green. My Collection. (Page 50.)

Fig. 2.—*Carbonicola acuta.* Right valve, showing a slight indication of a posterior lateral tooth. Same locality. My Collection. (Page 50.)

Fig. 3—42.—*Carbonicola acuta.* A series from the same locality, exhibiting several variations in detail and form of the hinge apparatus. (Page 50.)

Fig. 43.—*Carbonicola acuta.* A left valve from the Collection of the Woodwardian Museum, Cambridge, from Bradford, Yorkshire, showing the absence of a posterior lateral tooth. (Page 50.)

Fig. 44.—*Carbonicola subconstricta.* A right valve from the same Collection and locality, showing a posteriorly diverging cardinal tooth with a corresponding pit posterior to it to receive the cardinal tooth of the opposite valve, and the absence of a lateral tooth. (Page 59.)

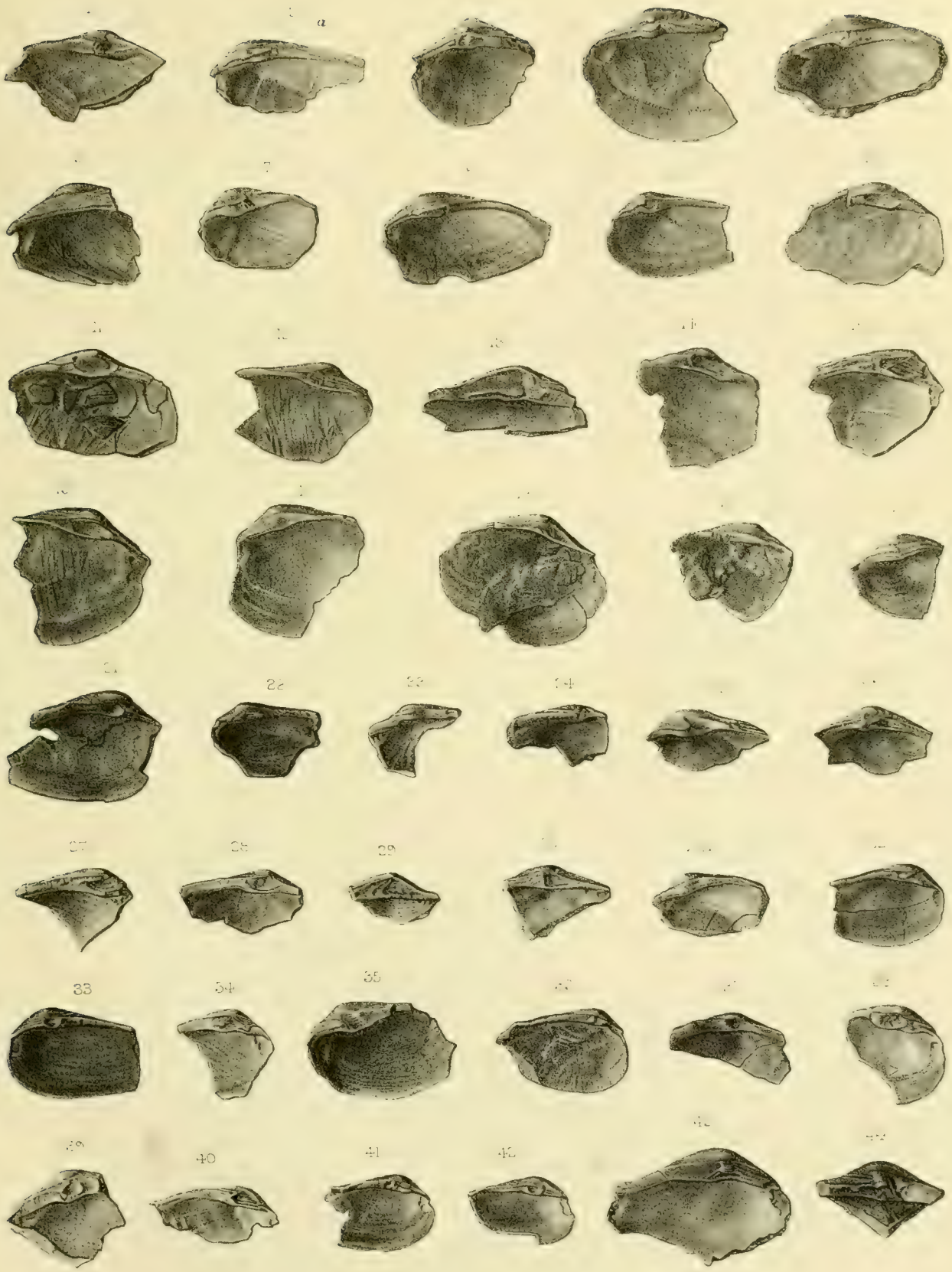

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PLATE VII.

Fig. 1.—*Carbonicola Polmontensis.* The cast of a full-grown example from Omoa, U. C. M. Scotland. Collection of Mr. James Nielson. (Page 58.)

Fig. 2.—*Carbonicola Polmontensis.* Cast showing the pallial line and the adductor muscle scars, from Kirkwood, U. C. M., Scotland. Same Collection. (Page 58.)

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Figs. 11 and 15.—*Carbonicola subconstricta.* Casts of large forms, showing pallial line and adductor scars from above the thin bed, Burnley. Collection of Mr. George Wild. (Page 59.)

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Fig. 14 *a*.—A view of fig. 14 seen from above. (Page 59.)

Fig. 16.—*Carbonicola obtusa.* From the Lower Coal-measures of North Staffordshire, Whitfield Colliery. The shale has been worked away from these valves since the drawing was made, and the hinge-plates are to be seen on Pl. XI, fig. 1. My Collection. (Page 61.)

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Figs. 26 *a* and 29 *a*.—Two of the specimens showing the casts of the umbones and hinge-line. (Page 63.)

Figs. 30 and 31.—*Carbonicola nucularis.* Two testiferous specimens from beds of the same horizon, Talk-o'-th'-Hill. My Collection. (Page 63.)

Figs. 32—42.—*Carbonicola nucularis.* A further series from the roof of the Hard Mine Coal, North Staffordshire. My Collection. (Page 63.) The number 39 on the left-hand side should be 36.

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PLATE VIII.

Fig. 1.—*Carbonicola gibbosa.* From the roof of the Moss Coal, Fenton, showing anterior end view and deep lunule. Collection of Mr. John Ward, F.G.S. (Page 65.)

Fig. 1 *a.*—The same shell. Lateral view.

Fig. 1 *b.*—The same shell, showing the umbones, external ligament, and upper surface.

Fig. 2.—*Carbonicola gibbosa.* Another example from the same bed. Collection of Mr. J. Ward, F.G.S. (Page 65.)

Figs. 3—7.—*Carbonicola subrotunda.* A series from the Lower Coal-measures of North Staffordshire, exact horizon not known, but some distance above the Hard Mine Seam. The bed was passed through in sinking the Adderley Green Colliery. My Collection. (Page 65.)

Figs. 4 *a* and 5 *a.*—The upper surfaces, umbones, lunule, and external ligaments of figs. 4 and 5. (Page 65.)

Fig. 8.—*Carbonicola turgida.* A typical specimen from Stubb's Mine, Bardsley. My Collection. (Page 66.)

Fig. 8 *a.*—The same specimen, seen from above. (Page 66.)

Fig. 9.—*Carbonicola turgida.*—Showing the hinge-plate and interior of a right valve. Stanley Main Seam, Wakefield. My Collection. (Page 66.)

Figs. 10—12 *a.*—*Carbonicola turgida.* A series from the horizon of Stubb's Mine, Bardsley. Presented to me by Mr. George Wild. My Collection. (Page 66.)

Fig. 13.—*Carbonicola turgida.* Coalbrookdale. My Collection. (Page 66.)

Fig. 14.—*Carbonicola turgida.* A cast from the Splint Coal, Wishaw, in the Braidwood Collection of Dr. Hunter. (Page 66.)

Fig. 15.—*Carbonicola turgida.* A cast from the Ell Coal, Cambushlang. From the same Collection. (Page 66.)

Fig. 16.—*Carbonicola turgida.*—A cast showing muscle-scars from Shettleston, in the Collection of Dr. John Young. (Page 66.)

Fig. 16 *a.*—The same cast, viewed from above. (Page 66.)

Fig. 17.—*Carbonicola turgida.* A young and shortened form from the Collection of Dr. John Young. (Page 66.)

Fig. 17 *a.*—The same shell viewed from above.

Fig. 18.—*Carbonicola turgida.* Coalbrookdale. My Collection. (Page 66.)

Fig. 18 *a.*—The same shell viewed from the front, showing the deep heart-shaped lunule.

Fig. 18 *b.*—The same shell seen from above.

Fig. 19.—*Carbonicola turgida.* A large example from the North Staffordshire Coal-field. Horizon not known. My Collection. (Page 66.)

Fig. 20.—*Carbonicola turgida.* Coalbrookdale, Madeley Court. A pretty little shell, whose posterior end has not developed. In the Collection of the Woodwardian Museum, Cambridge. (Page 66.)

Fig. 21—25.—*Carbonicola turgida.* A series of young forms from the roof of the Moss-coal, Lane End Colliery, Fenton. My Collection. (Page 66.)

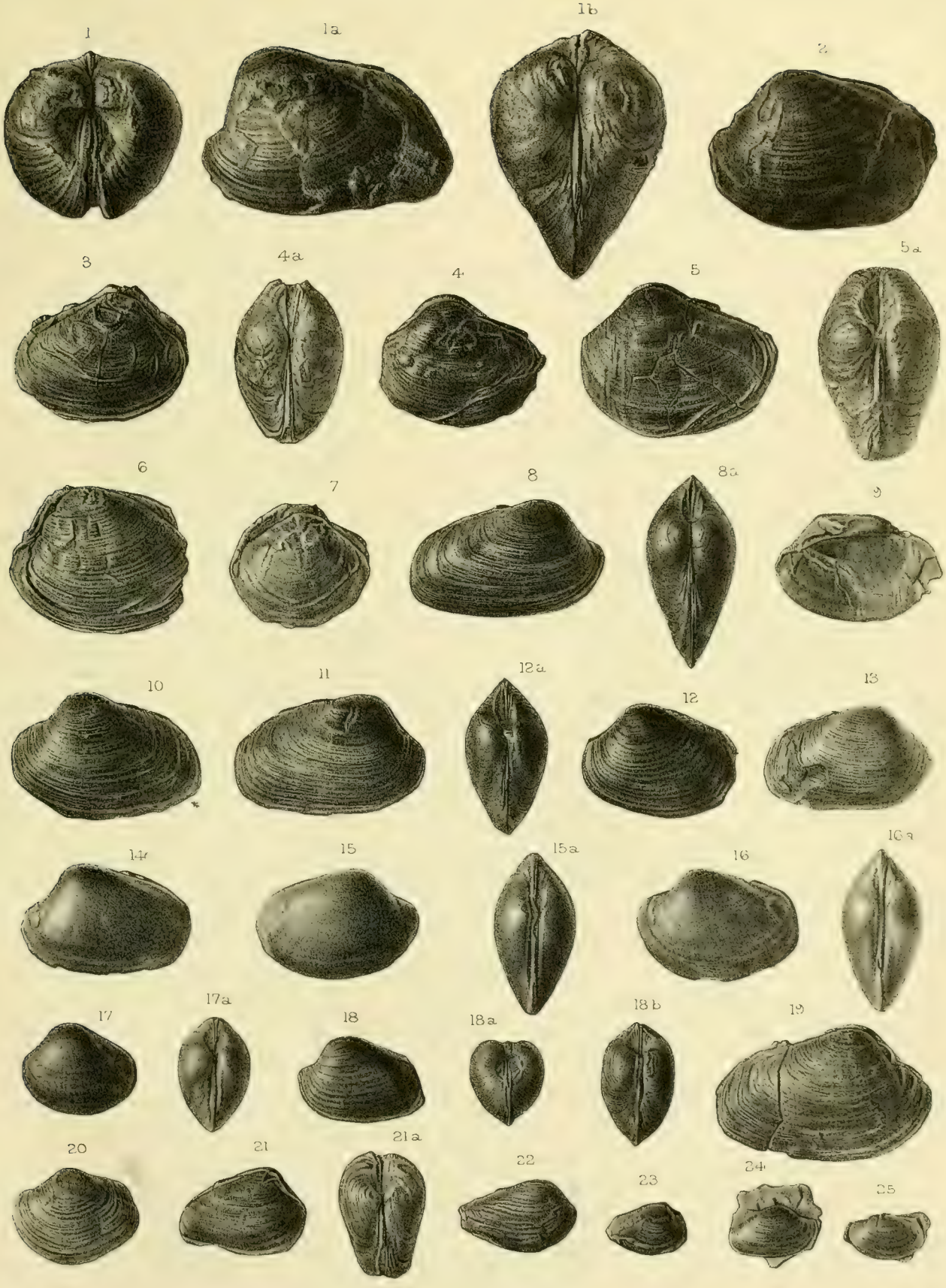
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PLATE IX.

Figs. 1 and 2.—*Carbonicola aquilina.* From the locality of the original specimen, Blue Flats, Coalbrookdale. My Collection. (Page 69.)

Figs. 3 and 4.—*Carbonicola aquilina.* From the Brooch Coal, Dudley. Presented to me by Mr. Wm. Madeley. My Collection. (Page 69.)

Fig. 5.—*Carbonicola aquilina.* From old workings at Whitley, Northumberland, the original locality of Professor King's *Anthracosia Beaniana*, showing the anterior two-thirds of the hinge-plate. My Collection. (Page 69.)

Figs. 6 and 7.—*Carbonicola aquilina.* In the Manchester Museum Collection, Owens College. (Page 69.)

Fig. 8.—*Carbonicola aquilina.* Showing typical anterior end from the Grains Ironstone, Dudley. Presented to me by Mr. Wm. Madeley. My Collection. (Page 69.)

Fig. 9. *Carbonicola aquilina.* A fine interior from the roof of the Bowling Alley Seam. Ivy House Colliery, Hanley. It has evidently been fractured, but repaired during life. My Collection. (Page 69.)

Figs. 10, 12, and 13.—*Carbonicola aquilina.* From the Coal-measures, Whitley, showing portions of the hinge-plate. Fig. 12 has the right valve crushed, but the hinge-plate is in shadow at (*a*). My Collection. (Page 69.)

Fig. 11.—*Carbonicola nucularis.* Whitley. Showing hinge-plate. My Collection. (Page 63.)

Fig. 14.—*Carbonicola aquilina.* Horizon of the Thick Coal, Tipton, South Staffordshire, showing the hinge-plate of the left valve, owing to the slipping of one valve over the other. Presented to me by Mr. Waring. My Collection. (Page 69.)

Figs. 15—24.—*Carbonicola aquilina.* Whitley. A series to show the variation in form and in the surface markings from one locality. My Collection. (Page 69.)

Fig. 25.—*Carbonicola aquilina.* From the Brooch Coal, Dudley. My Collection. (Page 69.)

Figs. 26—30.—*Carbonicola aquilina.* Clough Hall Collieries, North Staffordshire. Pyritised specimens in black shale about the horizon of the Banbury seams. Figs. 29 and 30 show a strongly wrinkled periostracum. My Collection. (Page 69.)

Figs. 31—36.—*Carbonicola aquilina.* A series from one horizon in the Wigan Coal-field showing the typical form of the *Unio lateralis* of Brown. Figs. 35 and 36 are much elongated transversely. (Page 69.)

Fig. 37.—*Carbonicola aquilina.* From roof of the Hard Mine Coal. Hulme Colliery, Adderley Green. My Collection. (Page 69.)

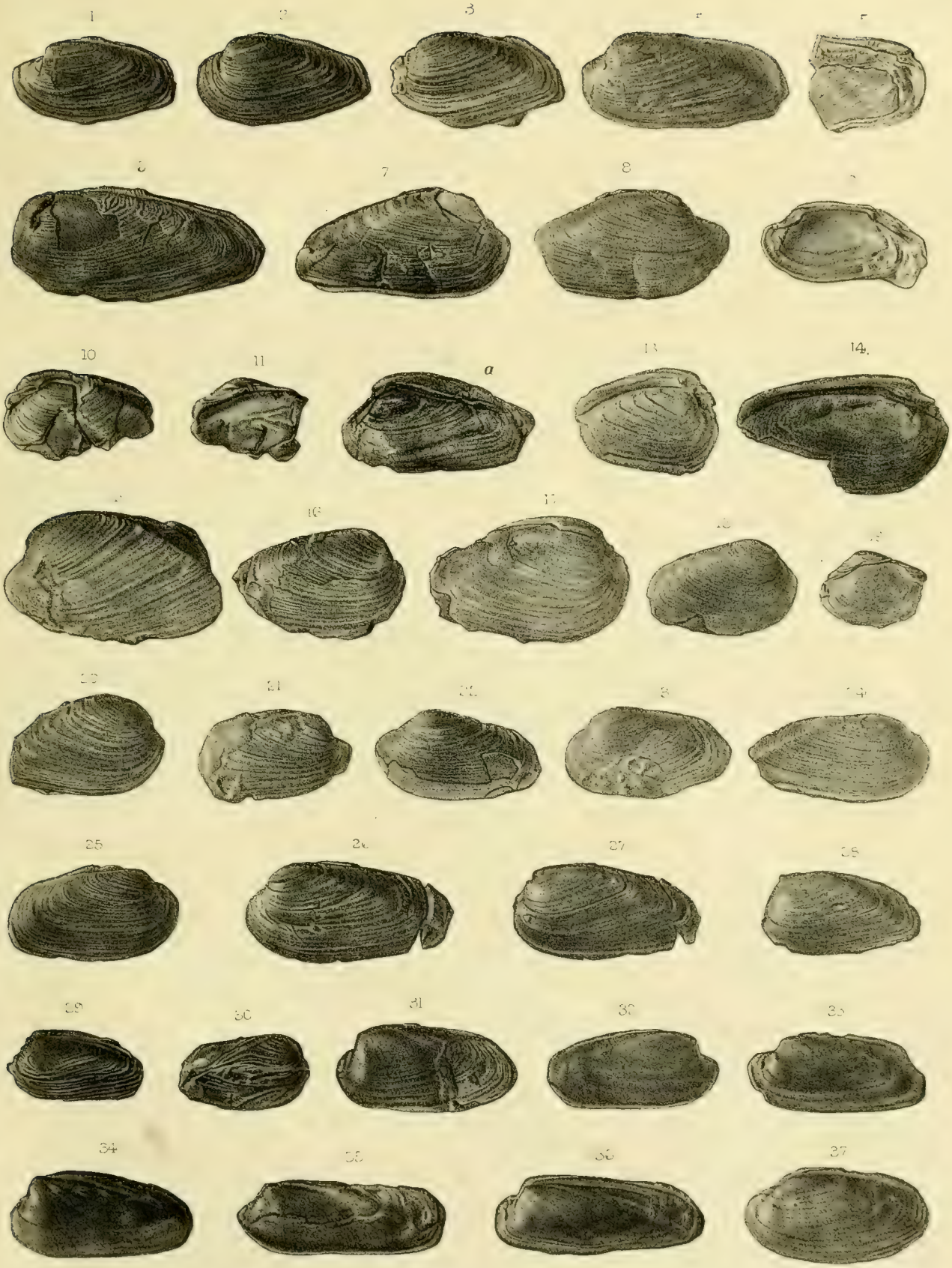
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PLATE X.

Fig. 1.—*Carbonicola aquilina*. A large form from the roof of the Moss Coal, Longton. Collection of Mr. John Ward, F.G.S. (Page 69.)

Figs. 2—6.—*Carbonicola aquilina*. A series from the roof of the Moss (or Eastling) Coal. Lane End Colliery, Fenton. My Collection. (Page 69.)

Figs. 7—17.—*Carbonicola aquilina*. A series to show variability in form, from the roof of the Hard Mine Coal, Adderley Green. My Collection. (Page 69.)

Fig. 18.—*Carbonicola aquilina*. From a plaster-of-Paris cast. The original passed through my hands in transit from Mr. George Wild to Professor Amalizky, of Warsaw. From the Stubb's Mine, Bardsley. Cast in my Collection. (Page 69.)

Figs. 19—42.—*Carbonicola aquilina*. A series of casts from the roof of the Hard Mine Coal, Adderley Green, to show stages of growth and the variation in form of even young examples, the smallest forms resembling the *Unio phaseolus* of Sowerby. My Collection. (Page 69.)

Figs. 19 *a*, 20 *a*, 21 *a*.—Figs. 19, 20, and 21 viewed from above, showing casts of the hinge-line and umbones. The anterior adductor scars and those from the accessory pedal muscles above and posterior to them are well seen, also the sinuous line indicating the position of the hinge-teeth. (Page 69.)

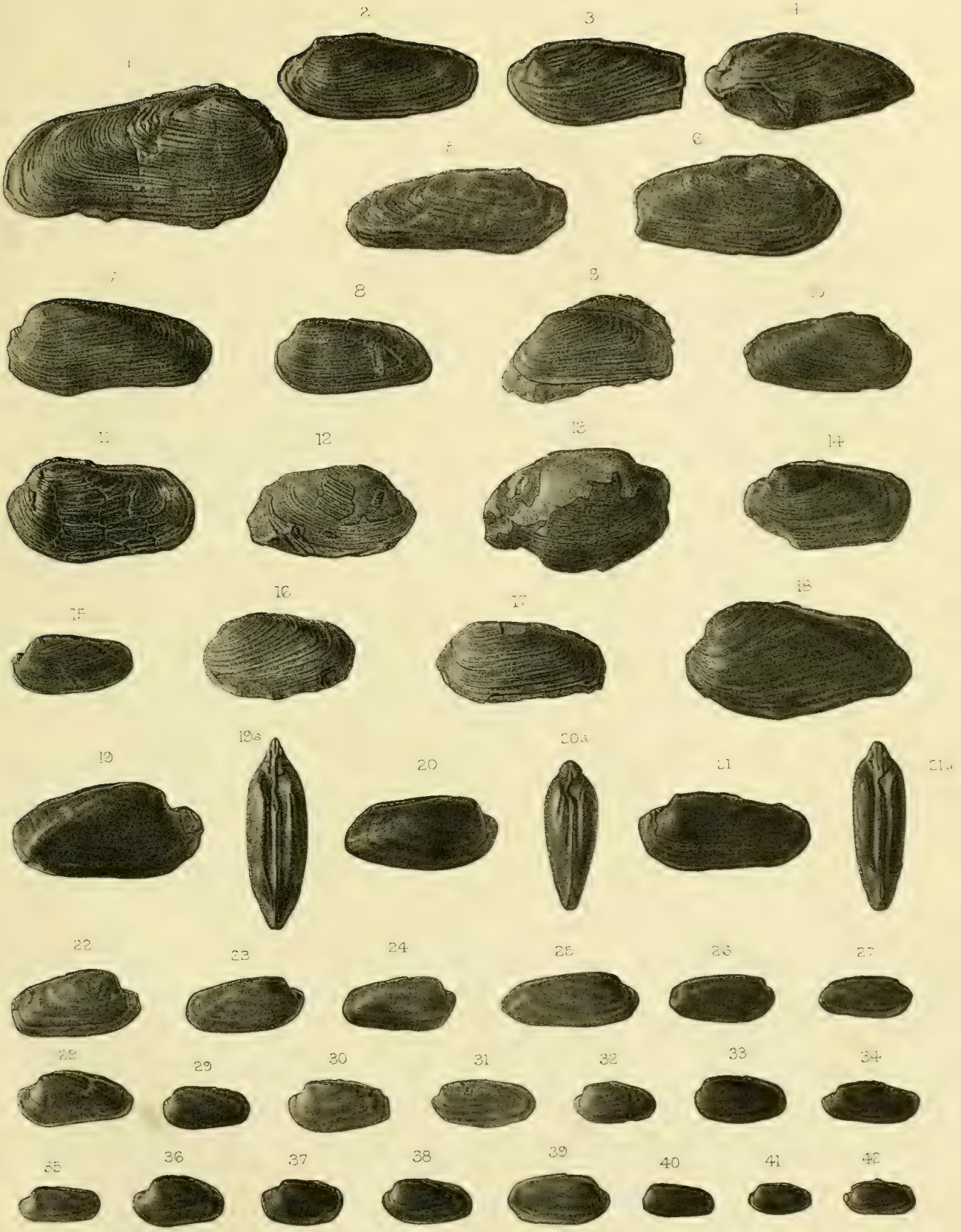

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PLATE XI.

Fig. 1.—*Carbonicola obtusa.* The hinge-plates of the shell figured on Pl. VII, fig. 16, showing a striated pit in the right valve posterior, and in the left anterior, to the cardinal tooth. (Page 61.)

Fig. 2.—*Carbonicola obtusa.* Cockshead Rock, Hulme Colliery, Adderley Green, North Staffordshire. Transverse section, showing a cavity between the hinge-plates, in which possibly was lodged an internal ligament or cartilage. The section is just posterior to the highest point of the umbones. My Collection. (Page 43.)

Figs. 3 and 4.—*Carbonicola angulata.* Two pyritised examples from the Low Bottom Bed. Fulledge, Burnley. In the Collection of Mr. George Wild. (Page 75.)

Fig. 5.—*Carbonicola angulata.* From same locality, a larger specimen. In the Collection of Mr. John Ward, F.G.S., of Longton. (Page 75.)

Figs. 6 and 7.—*Carbonicola similis.* Two typical specimens from the Brooch Coal Series, Dudley. My Collection. (Page 76.)

Fig. 7 *a.*—*Carbonicola similis.* Fig. 7 viewed from above, showing the hollow character of the dorsal slope.

Fig. 8.—*Carbonicola similis.* Cast showing muscle-scars and pallial line. Springhill Colliery, Ayrshire. In the Collection of Mr. Beveridge. (Page 76.)

Fig. 8 *a.*—The same viewed from above, showing the accessory pedal scars.

Figs. 9—13.—*Carbonicola similis.* A series from the Brooch Coal-beds, Dudley, showing the change in shape of the posterior end by age. Presented to me by Mr. Wm. Madeley. My Collection.

Figs. 10 *a*, 11 *a.*—*Carbonicola similis.* Figs. 10 and 11 viewed from above, showing external ligament and general shape of the superior surface. (Page 76.)

Figs. 14, 14 *a.*—*Carbonicola nucularis.* Two views of a very testiferous pyritised specimen with much-wrinkled periostracum from the horizon of the Banbury, ? Hard Mine, Talk-o'-th'-Hill, North Staffordshire. My Collection. (Page 63.)

Fig. 15.—*Carbonicola similis.* Brooch Coal Series, Dudley. To show the hinge-plate of the right valve. My Collection. (Page 76.)

Fig. 16, 16 *a.*—*Carbonicola nucularis.* Two views of a testiferous specimen from the spoil bank of a disused colliery at the west foot of Mow Cop, North Staffordshire, which from the fossil contents I believe to be about the horizon of the Hard Mine, showing much-wrinkled periostracum. My Collection. (Page 63.)

Figs. 17—23, 25—27. *Carbonicola similis.* A series from a thin bed above the Cockshead Rock, Hulme Colliery, Adderley Green, North Staffordshire, showing variations in shape often due to crushing. My Collection. (Page 76.)

Fig. 24.—*Carbonicola cuneiformis.* The roof of the Hard Mine Coal, Bucknall. My Collection. (Page 78.)

Fig. 24 *a.*—*Carbonicola cuneiformis*, viewed from above.

Figs. 28, 29.—*Carbonicola antiqua.* From the Calciferous Sandstone Series, Kilminning, Fife. My Collection. (Page 79.)

Fig. 28*a.*—*Carbonicola antiqua.* An imperfect view of the hinge-plate of fig. 28.

Fig. 30.—*Carbonicola antiqua.* This is not a cast, but the shell has been worn smooth by wave action. From the same bed. My Collection. (Page 79.)

Fig. 31.—*Carbonicola aquilina.* A very large and fine example from the roof of the Hard Mine Coal, Adderley Green Colliery, Longton. My Collection. (Page 69.)

Figs. 32 and 33.—*Carbonicola aquilina*, to show curious circular perforations. Collection of Mr. John Ward, F.G.S., Longton. (Page 74.)

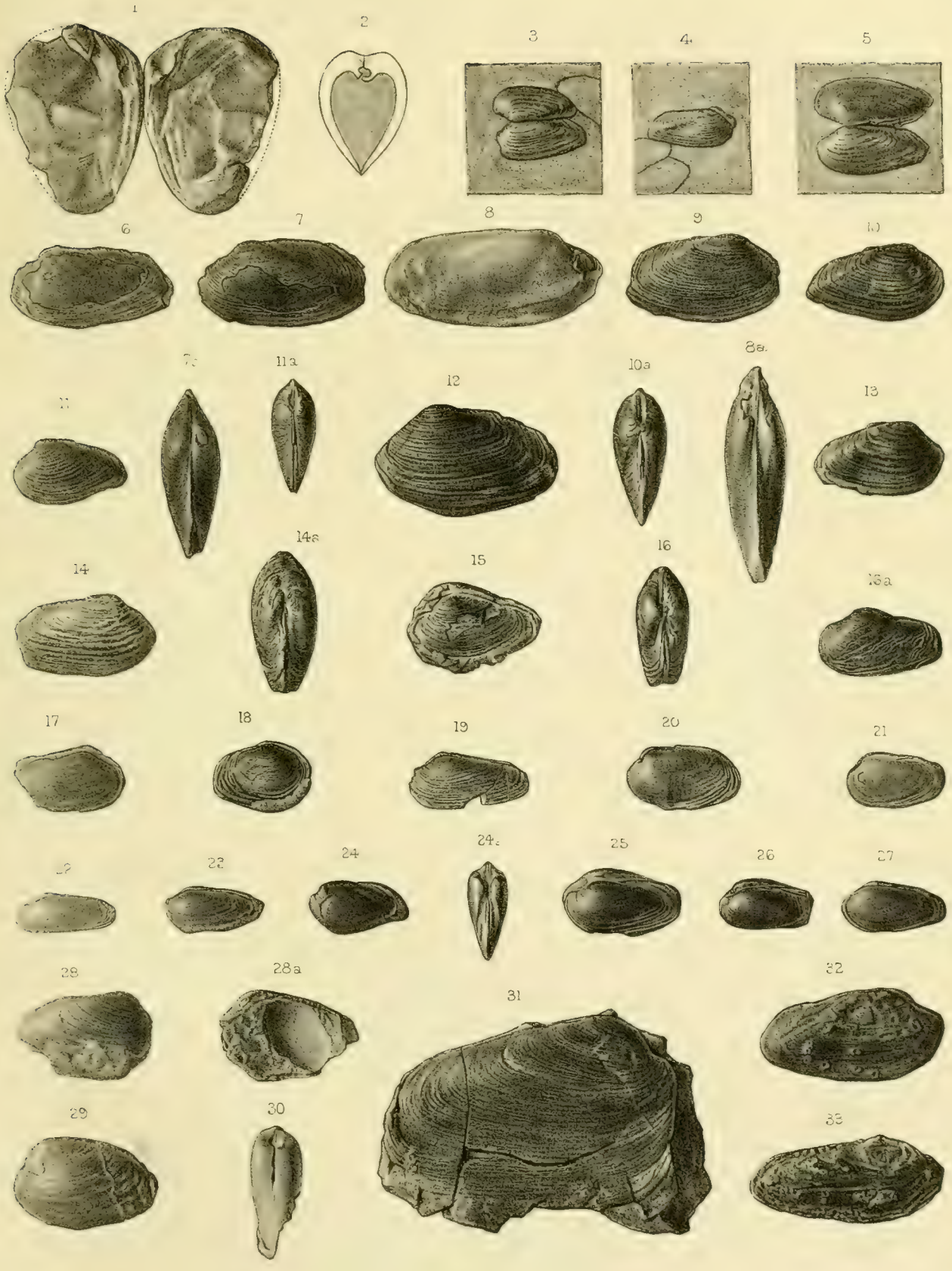
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PLATE XII.

Figs. 1 and 2.—*Anthracomya Adamsii.* From the Little Mine Ironstone of Great Fenton. My Collection. (Page 89.)

Fig. 3.—*Anthracomya Adamsii.* Right valve showing the straight and narrow hinge-line. Same locality. My Collection. (Page 89.)

Fig. 4.—*Anthracomya Adamsii.* Cast showing muscle-scars and longitudinal grooves on either side of the hinge-line. My Collection. Same locality. (Page 89.)

Figs. 5—9.—*Anthracomya Adamsii.* Same locality. Showing variations in form. My Collection. (Page 89.)

Fig. 9 *a*.—Fig. 9 viewed from above. The umbo is not eroded, but is incomplete. Same locality. My Collection. (Page 89.)

Fig. 10.—*Anthracomya Adamsii.* Showing distinct colour-bands. Same locality. My Collection. (Page 89.)

Fig. 11.—*Anthracomya Adamsii.* Aberrant form. Same locality. My Collection. (Page 89.)

Fig. 12.—*Anthracomya Adamsii.* Same locality. My Collection. (Page 89.)

Figs. 13, 15, 16.—*Anthracomya Adamsii.* Young forms to show stages of growth. Same locality. My Collection. (Page 89.)

Fig. 14.—*Anthracomya Adamsii.* Very young form. Burnwood Ironstone, Newchapel. My Collection. (Page 89.)

Figs. 17, 19.—*Anthracomya Adamsii.* Showing wrinkled periostracum. Little Mine Ironstone, Great Fenton. My Collection. (Page 89.)

Fig. 18.—*Anthracomya Adamsii.* An oval form not full-grown. Same locality. My Collection. (Page 89.)

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PLATE XIII.

Figs. 1—3.—*Anthracomya Adamsii*, var. *expansa*. From the Little Mine Ironstone, Great Fenton. My Collection. (Page 91.)

Fig. 4.—*Anthracomya dolabrata*. The type specimen from Prof. Prestwich's 'Geology of Coalbrookdale,' pl. xxxix, fig. 9, refigured by the Professor's kind permission. (Page 93.)

Figs. 5—9 and 11.—*Anthracomya dolabrata*. A series from the Little Mine Ironstone of Great Fenton. My Collection. (Page 93.)

Fig. 7 *a*.—Fig. 7 seen from above, showing width. (Page 93.)

Fig. 9 *a*.—Fig. 9 seen from above. (Page 93.)

Figs. 10 and 12.—*Anthracomya modiolaris*. Short truncate form from the roof of the Holly-Lane Coal, North-Staffordshire Coal-field. In the Collection of Mr. John Ward, F.G.S. (Page 95.)

Figs. 13 and 16.—*Anthracomya Wardi*. Smooth keelless form from the Shale Coal of Wakefield. From the Collection of Mr. David Campbell of Wakefield. (Page 105.)

Fig. 14.—*Anthracomya modiolaris*. The cast of a large form from the Upper Coal-measures of Old Cummock, Ayrshire. From the Collection of Mr. Smith of Kilwinning. (Page 95.)

Fig. 15.—*Anthracomya Wardi*. From the roof of the Eight-foot Coal of Durie, Fife. My Collection. (Page 105.)

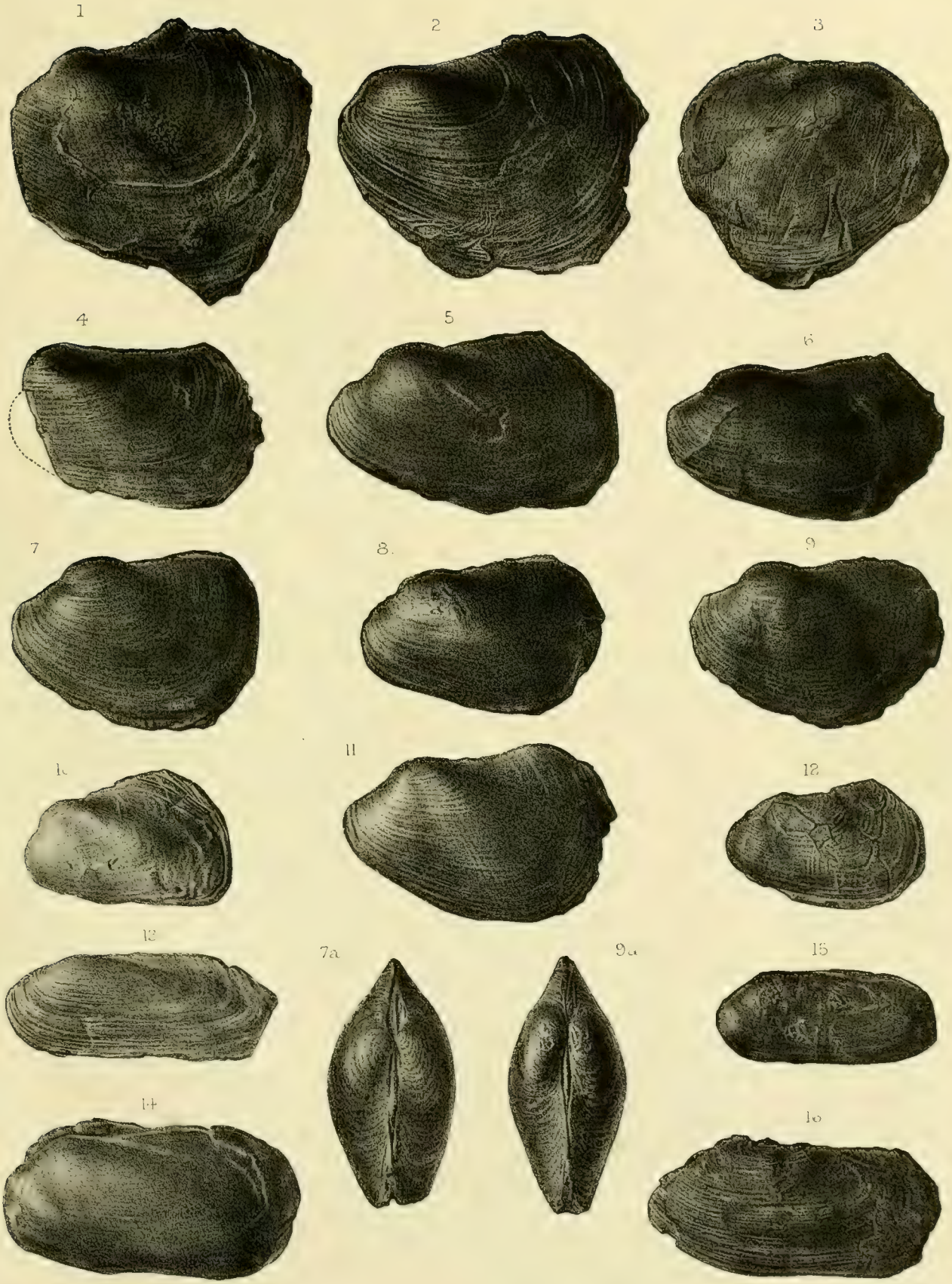
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PLATE XIV.

Figs. 1—4.—*Anthracomya modiolaris.* From the roof of the Holly-Lane Coal, Hanley and Bucknall Colliery. My Collection. (Page 95.)

Fig. 5.—*Anthracomya modiolaris.* From the same horizon at Harecastle, North Staffordshire Coal-field. My Collection. (Page 95.)

Fig. 6.—*Anthracomya modiolaris.* From the roof of the Holly-Lane Coal, Bucknall. My Collection. (Page 95.)

Figs. 7 and 8.—*Anthracomya modiolaris.* From the same horizon; Adderley Green. In the Collection of Mr. John Ward, F.G.S., of Longton. (Page 95.)

Fig. 9.—*Anthracomya modiolaris.* A cast. The type specimen figured by Mr. Salter in the Iron-ores of South Wales, pl. ii, fig. 13, refigured by permission of the Director-General of the Geological Survey of Great Britain. In the Collection of the Geological Survey, Jermyn Street, London. (Page 95.)

Fig. 9 *a.*—The same specimen seen from above.

Fig. 10.—*Anthracomya modiolaris.* From Shettleston, Scotland. In the Collection of Mr. Beveridge of Glasgow. (Page 95.)

Fig. 11.—*Anthracomya modiolaris.* A cast from the Splint Coal, Wishaw. In the Braidwood Collection of Dr. Hunter. (Page 95.)

Fig. 11 *a.*—The same viewed from above.

Figs. 12—31.—*Anthracomya Williamsoni.* A series of all ages from the roof of the Hard Mine Coal at Adderley Green, North Staffordshire. My Collection. (Page 99.)

Fig. 32.—*Anthracomya modiolaris.* An example showing the hinge from Whitley, Northumberland. My Collection. (Page 95.)

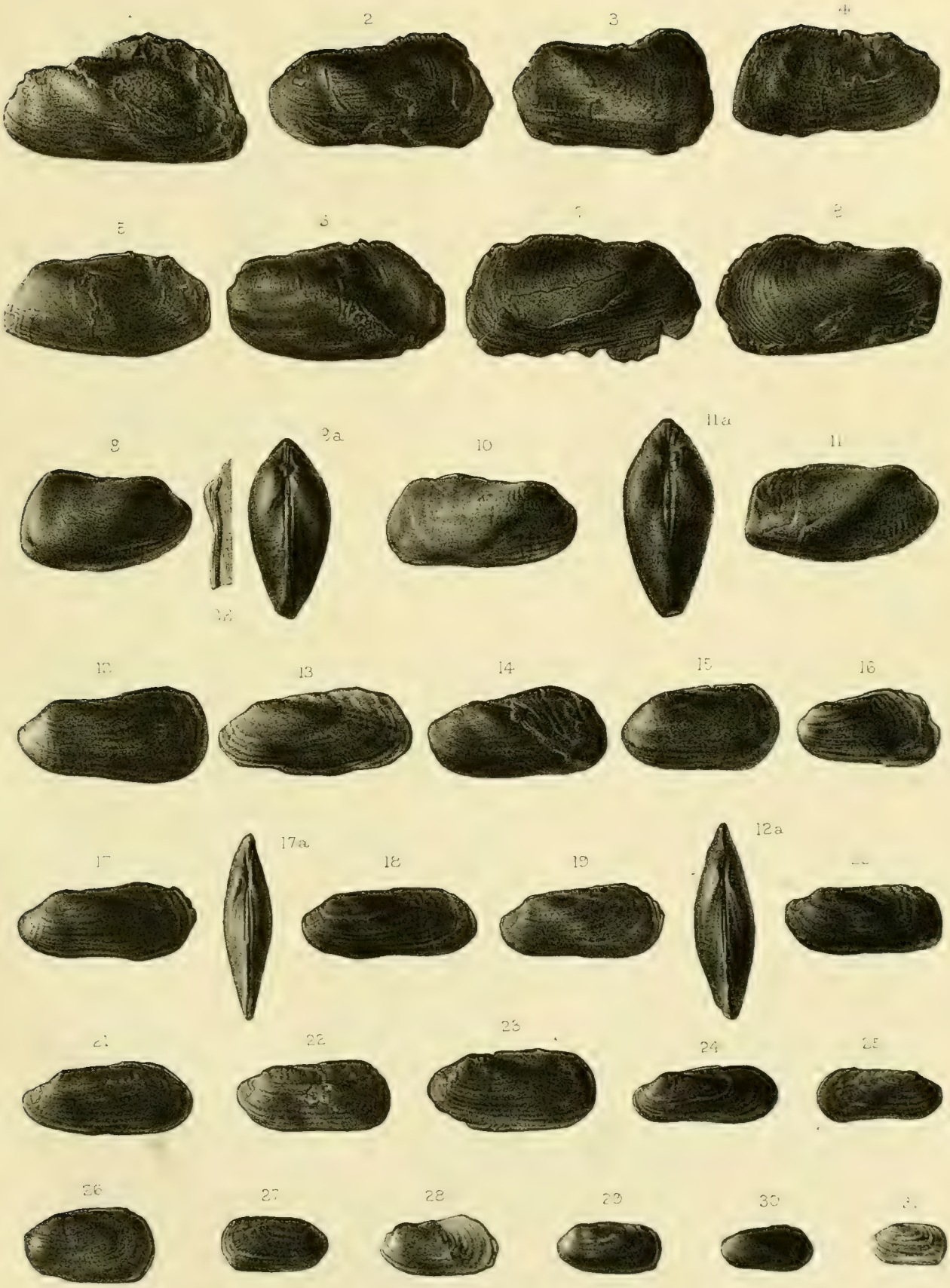
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PLATE XV.

Figs. 1—4.—*Anthracomya Wardi.* Crushed forms from the lower part of the Little Mine Ironstone, Fenton. My Collection. (Page 105.)

Figs. 5—9.—*Anthracomya Williamsoni*, var. *obtusa*. From the roof of the Hard Mine Coal of Longton and Bucknall. My Collection. (Page 103.)

Fig. 5 *a*.—Fig. 5 from above.

Fig. 10.—*Anthracomya Williamsoni.* (Page 99.)

Fig. 11.—*Anthracomya lanceolata.* Horizon uncertain. From the Glebe Colliery, Fenton. My Collection. (Page 104.)

Fig. 11 *a*.—The same viewed from above.

Fig. 12.—*Anthracomya Wardi.* Young form from the roof of the Holly Lane or Bowling Alley Coal ?, Bucknall, North Staffordshire. My Collection. (Page 105.)

Fig. 13.—*Anthracomya Wardi.* From Burnley. In the Collection of the Manchester Museum, Owens College. (Page 105.)

Fig. 14.—*Anthracomya Wardi.* The type specimen from the shale over the Holly Lane ? Coal, Adderley Green, North Staffordshire Coal-field. Collection of Mr. John Ward, F.G.S. (Page 105.)

Fig. 15.—*Anthracomya Wardi.* Shale over Burnwood Ironstone, Chell. North Staffordshire Coal-field. My Collection. (Page 105.)

Fig. 16.—*Anthracomya Wardi.* ? From near Pendle. In the Collection of the Manchester Museum, Owens College. (Page 105.)

Fig. 17.—*Anthracomya Wardi.* Young form. Burnley. Same Collection. (Page 105.)

Fig. 18.—*Anthracomya Wardi.* Pyritised specimen from the Fulledge Colliery, Burnley. Collection of Mr. George Wild. (Page 105.)

Fig. 19.—*Anthracomya Wardi.* An uncrushed specimen from the neigbourhood of Burnley. Owens College Collection. (Page 105.)

Fig. 20. *Anthracomya Wardi.* From the shale above the Bowling Alley Coal at Whitfield, North Staffordshire Coal-field. My Collection. (Page 105.)

Fig. 21. *Anthracomya senex.* The original of the type of Mr. Salter's species; Iron-ores of South Wales, pl. ii, fig. 12. From the Collection of the Geological Survey, Jermyn Street, London. (Page 111.)

Fig. 21 *a*.—The same viewed from above, showing the hinge and wrinkled periostracum.

Figs. 22—28.—*Anthracomya senex.* A series from the horizon of the Cockshead Ironstone of Adderley Green, North Staffordshire. My Collection. (Page 111.)

Figs. 29—49.—*Anthracomya pulchra.* A series showing the alteration of shape during growth. From the lower part of the Burnwood Ironstone, Newchapel, North Staffordshire Coal-field. My Collection. (Page 114.)

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PLATE XVI.

Fig. 1.—*Anthracomya subcentralis.* From No. 6 Pit, Victoria, South Wales Coal-field. In the Collection of the Cardiff Museum. (Page 109.)

Figs. 2 and 3.—*Anthracomya pumila.* Same Collection. (Page 108.)

Fig. 4.—*Anthracomya subcentralis.* From the roof of the Hard Mine Coal, Adderley Green, North Staffordshire Coal-field. My Collection. (Page 109.)

Figs. 5—9.—*Anthracomya subcentralis.* A series of crushed examples from the horizon of the Cockshead Ironstone, Hulme Colliery, Longton. My Collection. (Page 109.)

Fig. 10.—*Anthracomya Phillipsii.* The type specimen. From the Upper Coal-measures, Ardwick. In the Collection of the Manchester Museum, Owens College. (Page 120.)

Fig. 11.—*Anthracomya Phillipsii.* From the Bassey Mine Ironstone, Chatterley, North Staffordshire. My Collection. (Page 120.)

Figs. 12, 13, 13 *a*, 14.—*Anthracomya Phillipsii.* Complete specimens from the Knowles Ironstone, Fenton. My Collection. (Page 120.)

Fig. 15.—*Anthracomya Phillipsii.*—An elongate form from the Bassey Mine Ironstone, Chatterley, North Staffordshire. My Collection. (Page 120.)

Fig. 16.—*Anthracomya Phillipsii.*—Like the type; from the Bassey Mine Ironstone of Chatterley, North Staffordshire. My Collection. (Page 120.)

Figs. 17 and 19.—*Anthracomya lævis*, var. *Scotica.* Limehouse Water, West Calder; Lower Carboniferous. Collection of the Geological Survey of Scotland. (Page 123.)

Fig. 18.—*Anthracomya lævis*, var. *Scotica.* The type figured by Mr. R. Etheridge, jun., 'Geol. Mag.,' 1877, dec. 2, vol. iv, pl. xii, fig. 8. Same Collection. (Page 123.)

Fig. 20.—*Anthracomya lævis*, var. *Scotica?* Water of Leith. This specimen was labelled by Mr. R. Etheridge, jun., *Anthracoptera papyracea*, MS., doubtless on account of the sinuated posterior border. Same Collection. (Page 123.)

Figs. 21, 22.—*Anthracomya minima.* Large specimens from Black Adder Water, Duns; Lower Carboniferous of Scotland. Same Collection. (Page 116.)

Fig. 23.—*Anthracomya lævis.* A specimen from the South Joggins Coal-field, Nova Scotia. My Collection. (Page 123.)

Figs. 24, 26—30.—*Anthracomya minima.* From the Middle Coal-measures of Lancashire Coal-field, Prestolee, in a band of ironstone. My Collection. (Page 116.)

Figs. 25, 31—34.—*Anthracomya minima.* From the Knowles Ironstone. Railway-cutting north of Golden Hill, North Staffordshire. My Collection. (Page 116.)

Figs. 35—39.—*Anthracomya minima*, var. *carinata.* From Prestolee, Middle Coal-measures, Lancashire. In the Collection of C. Roeder, Esq., of Manchester. (Page 119.)

Fig. 40.—*Anthracomya pumila.* Coal-measures, Merthyr Tydvil. From the Strickland Collection, Woodwardian Museum. (Page 108.)

Fig. 41.—*Anthracomya obovata.* From the roof of the Hard Mine Coal, Mossfield Colliery, Longton. My Collection. (Page 110.)

Figs. 42, 43.—*Anthracomya lævis*, var. *Scotica.* From the Cannel Coal, Wigan. My Collection. (Page 123.)

Figs. 44—48.—*Anthracomya Valenciensis.* From Dalmeny railway-cutting. Lower Carboniferous of Scotland. Collection of the Geological Survey of Scotland. (Page 113.)

Fig. 44 *a*.—The shell of fig. 44 viewed from above. (Page 113.)

Fig. 49.—*Anthracomya modiolaris.* One of the original type specimens figured by Mr. Sowerby in Professor Prestwich's 'Geology of Coalbrookdale.' In the Collection of the Natural History Museum, South Kensington. (Page 95.)

Figs. 50, 50 *a*.—*Anthracomya modiolaris.* Two views of the second type specimen figured by Mr. Sowerby in the above work, a view only, as in 5 *a*, being given. The same Collection. (Page 95.)

Fig. 51.—*Anthracomya modiolaris.* A specimen like Mr. Salter's type (Pl. XIV, fig. 9), from Coalbrookdale. In the same Collection. (Page 95.)

Fig. 52.—*Anthracomya modiolaris.* From the Middle Measures? of the Durham Coal-field. My Collection. (Page 95.)

Fig. 53.—*Anthracomya modiolaris.* From the Grains Ironstone, Dudley, South Staffordshire Coal-field. My Collection. (Page 95.)

Fig. 54.—*Anthracomya Adamsii?* An aberrant form from the South Wales Coal-field. In the Collection of the Cardiff Museum. (Page 89.)

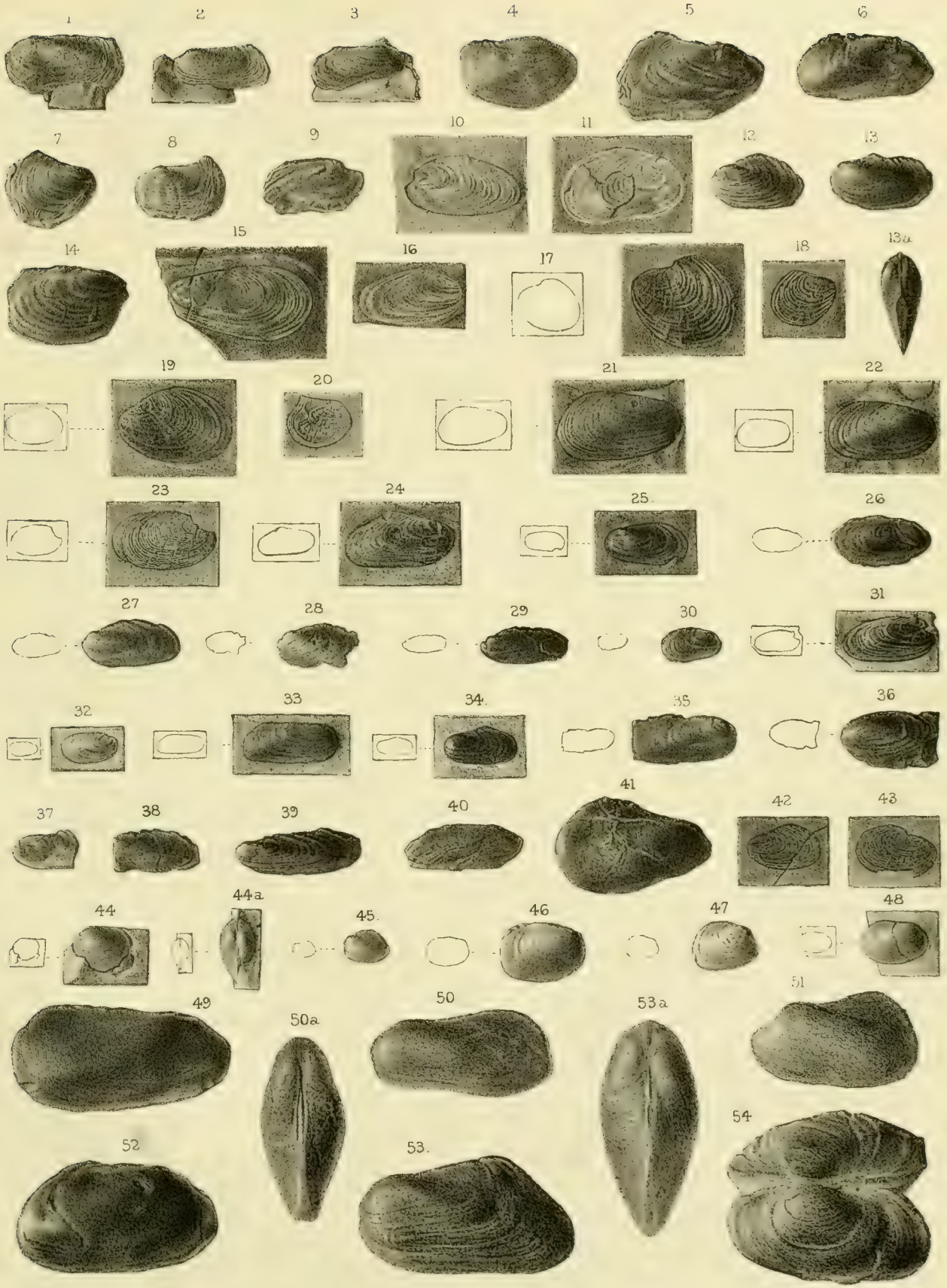
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PLATE XVII.

Figs. 1 and 2.—[*Modiola*] *Macadami*, var. *subparallela*. From the Ballycastle Coal-measures, co. Antrim. In the Collection of Mr. Joseph Wright of Belfast. (Page 88.) Since page 88 was printed I have discovered from a fine specimen in the Belfast Museum, showing the hinge, that the shells from Ballycastle now figured are not of the genus Modiola, but belong to the Anthracomyæ.

Fig. 3.—*Anthracomya subcentralis*. The roof of the Four-foot Coal, Bilboa, Castlecomer. Collection of the Geological Survey, Jermyn Street. (Page 109.)

Figs. 4 and 5.—*Anthracomya subcentralis*. Bilboa, Queen's Co. Collection of the Geological Survey of Ireland, Dublin. (Page 109.)

Figs. 6 and 7.—*Anthracomya Williamsoni*. Same locality and Collection. (Page 99.)

Figs. 8, 9, 10, 12—15.—*Naiadites modiolaris*. Showing the striated hinge-plate; obsolete anterior hinge-tooth and trifid anterior adductor scars. From the Shale above the Bowling Alley Coal, Hanley and Bucknall Colliery, North Staffordshire. My Collection. (Page 131.)

Fig. 11.—*Naiadites?* sp. A portion of the shell magnified to show prismatic structure, from a specimen sent me by Dr. John Young of the Hunterian Museum. (Page 131.)

Figs. 16, 16 *a*, 18, 18 *a*.—*Naiadites modiolaris*. Two views of two casts showing anterior and posterior muscle-scars and the mantle-line. Roof of the Hard Mine Coal, Adderley Green, North Staffordshire. My Collection. (Page 131.)

Fig. 17.—*Naiadites modiolaris*. To show the flattened right valve. Same locality and Collection. (Page 131.)

Figs. 19, 20.—*Naiadites modiolaris*. To show variation in contour. Same locality and Collection. (Page 131.)

Fig. 21.—*Naiadites modiolaris*. From the locality whence the types were procured. Coalbrookdale. My Collection. (Page 131.)

Figs. 22—26.—*Naiadites modiolaris*. Testiferous specimens showing lines of growth and variation in shape. Roof of the Hard Mine Coal, Adderley Green, North Staffordshire. My Collection. (Page 131.)

Figs. 27—30.—*Naiadites modiolaris*. A series of young specimens from the same locality. My Collection. (Page 131.)

Figs. 31—38.—*Naiadites triangularis*. A series showing the changes resulting during growth. From the same locality. My Collection. (Page 135.)

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PLATE XVIII.

Figs. 1—5.—*Naiadites carinata.* A series of casts showing the muscle-scars and line of the mantle, and the variation of contour. From the roof of the Hard Mine Coal, Adderley Green, North Staffordshire. My Collection. (Page 138.)

Figs. 4 and 5.—*Naiadites carinata.* Testiferous examples from the same locality. My Collection. (Page 138.)

Figs 7—9.—*Naiadites carinata.* Casts from the Stanley Main Seam, Wakefield. My Collection. (Page 138.)

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Fig. 12.—*Naiadites carinata.* An obese form from the same locality. My Collection. (Page 138.)

Figs. 13, 14.—*Naiadites carinata.* Two views of a very obese form showing the much-wrinkled periostracum. Same locality. My Collection. (Page 138.)

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Fig. 16.—*Naiadites carinata.* An aberrant form from the same locality. In the Collection of John Ward, Esq., F.G.S., of Longton. (Page 138.)

Fig. 17.—*Naiadites quadrata.* A large compressed form from the roof, Hard Mine Coal, North Staffordshire. My Collection. (Page 140.)

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Fig. 20.—*Naiadites quadrata.* A crushed testiferous example from above the Woodhead Coal of Froghall. My Collection. (Page 140.)

Figs. 21, 23—25.—*Naiadites quadrata.* Uncrushed examples from the roof of the Hard Mine Coal, Adderley Green, North Staffordshire. My Collection. (Page 140.)

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Figs. 26—35.—*Naiadites elongata.* A series from the Knowles Ironstone of Fenton Park, North Staffordshire, figs. 31 and 32 being the type forms. (Page 142.)

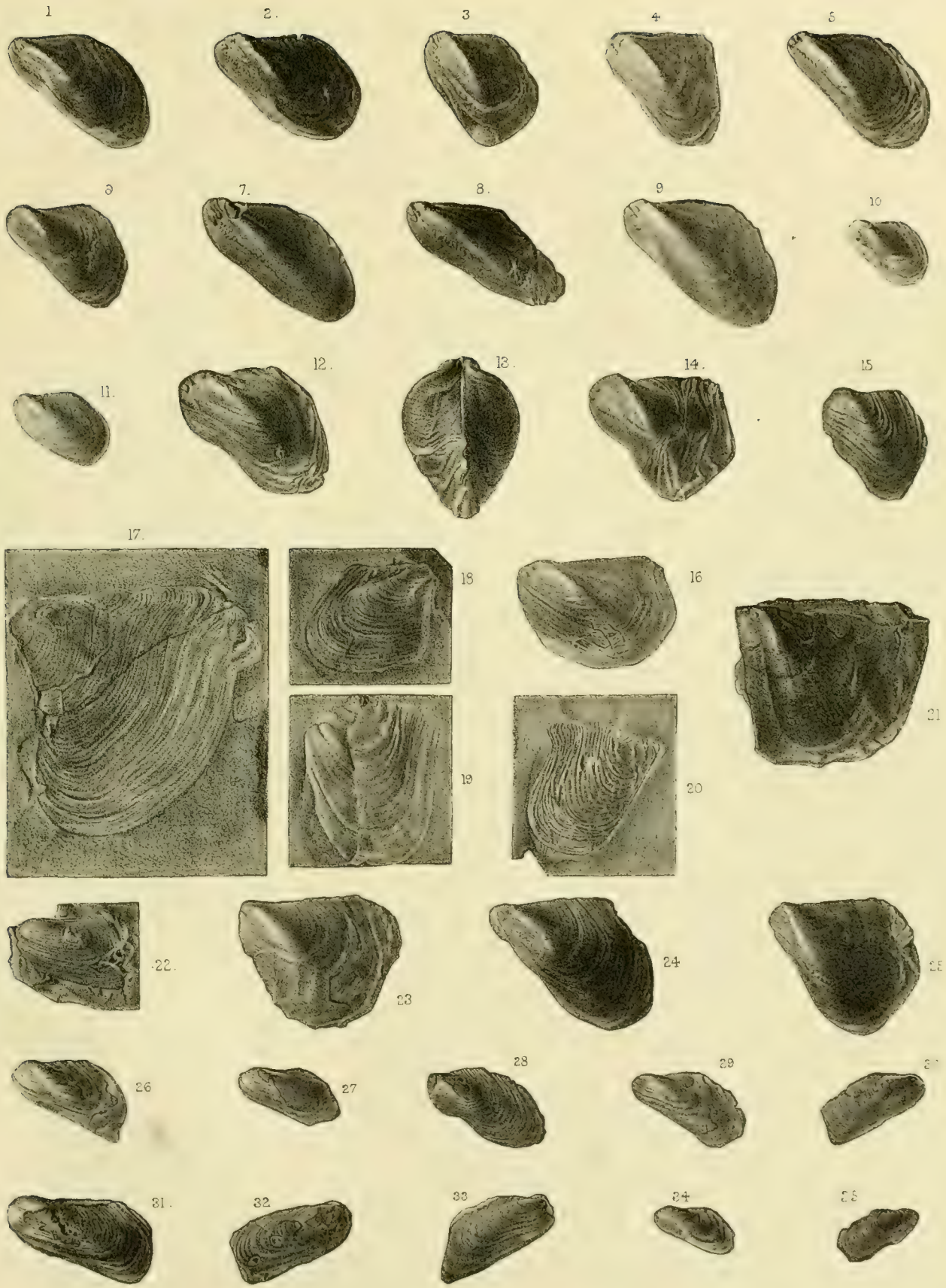

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PLATE XIX.

Figs. 1—7.—*Naiadites obesa*. A series of weathered specimens showing the structure of the hinge, and the pits for the anterior muscles. From the Calciferous-Sandstone Series of Fife. My Collection. (Page 144.)

Fig. 8.—*Naiadites obesa*. A specimen of a right valve, showing the emarginate posterior border. From Oakbank Quarry, Midcalder. My Collection. (Page 144.)

Figs. 9 and 10.—*Naiadites obesa*.—Two right valves from the Calciferous Sandstone-Series of Kilrenny Mill, Fife. My Collection. (Page 144.)

Fig. 11.—*Naiadites obesa*. A left valve. From the same locality. My Collection. (Page 144.)

Figs. 12—14.—*Naiadites obesa*. The originals of Mr. R. Etheridge's, jun., *Anthracoptera tumida*. From the Shale above the "Brownstone" portion of the Boness Lower Ironstone. Edge-Coal Series. Collection of the Geological Survey of Scotland, Edinburgh. (Page 144.)

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Fig. 16.—*Naiadites obesa*. The largest of the original shells figured by Mr. R. Etheridge, jun., 'Quart. Journ. Geol. Soc.,' vol. xxxiv, 1878, pl. i, fig. 12 *a*. From Micaceous Sandstone, Drumsheugh. In the Collection of the Museum of Science and Art, Edinburgh. (Page 144.)

Figs. 17—19.—*Naiadites magna*, n. sp. From the Black Band Ironstone, Bankend, Lesmahagow. From the Braidwood Collection of Dr. Hunter. (Page 151.)

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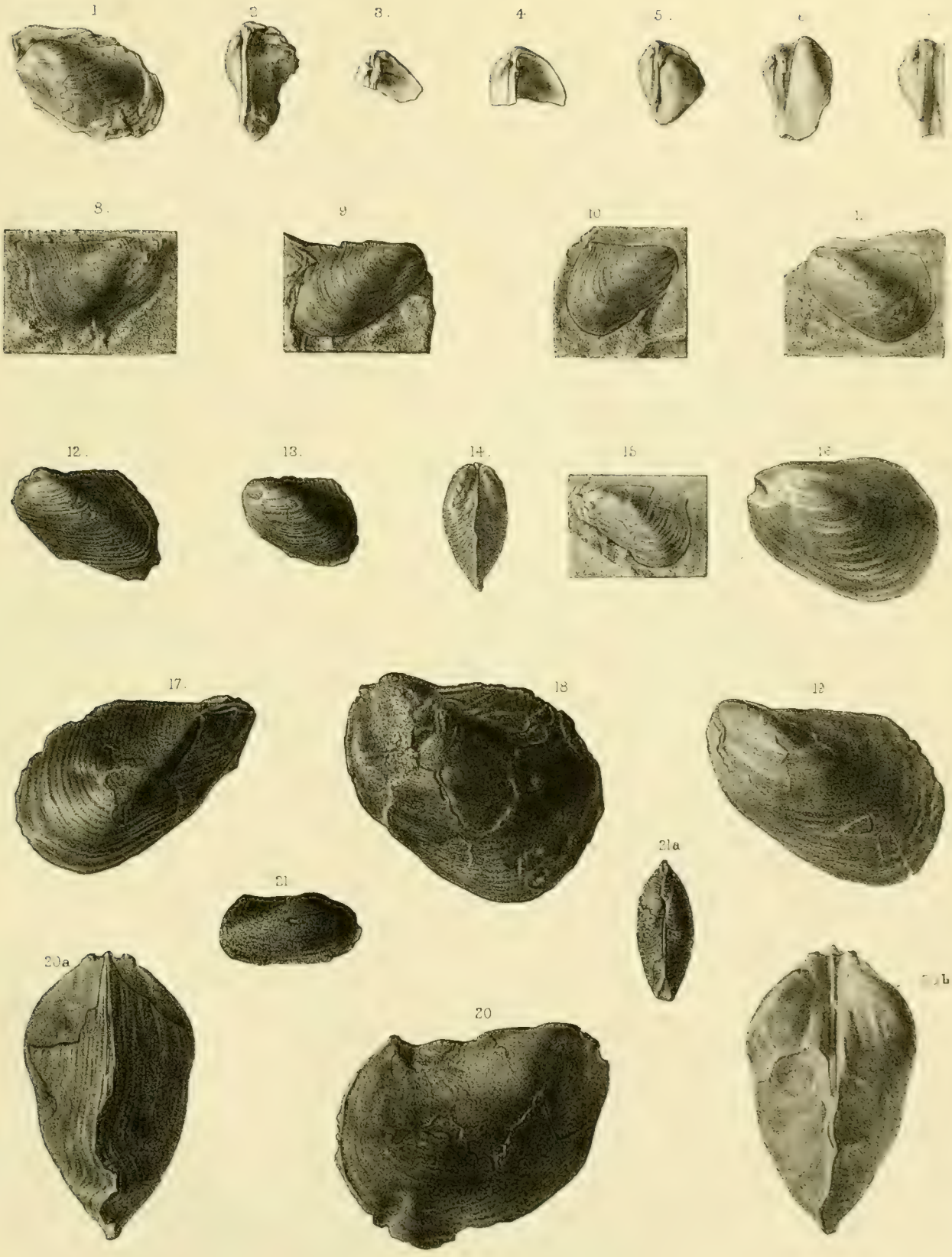

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PLATE XX.

Figs. 1, 2, 3, and 7.—*Naiadites crassa.* A series of valves showing the striated hinge-plate, and almost obsolete cardinal tooth and pit-like muscle-scars. From the Cults Lime Works, Pitlessie, Fife. My Collection. (Page 147.)

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Fig. 8.—*Naiadites crassa.* The worn surface of a left valve. From Cults, Pitlessie, Fife. My Collection. (Page 147.)

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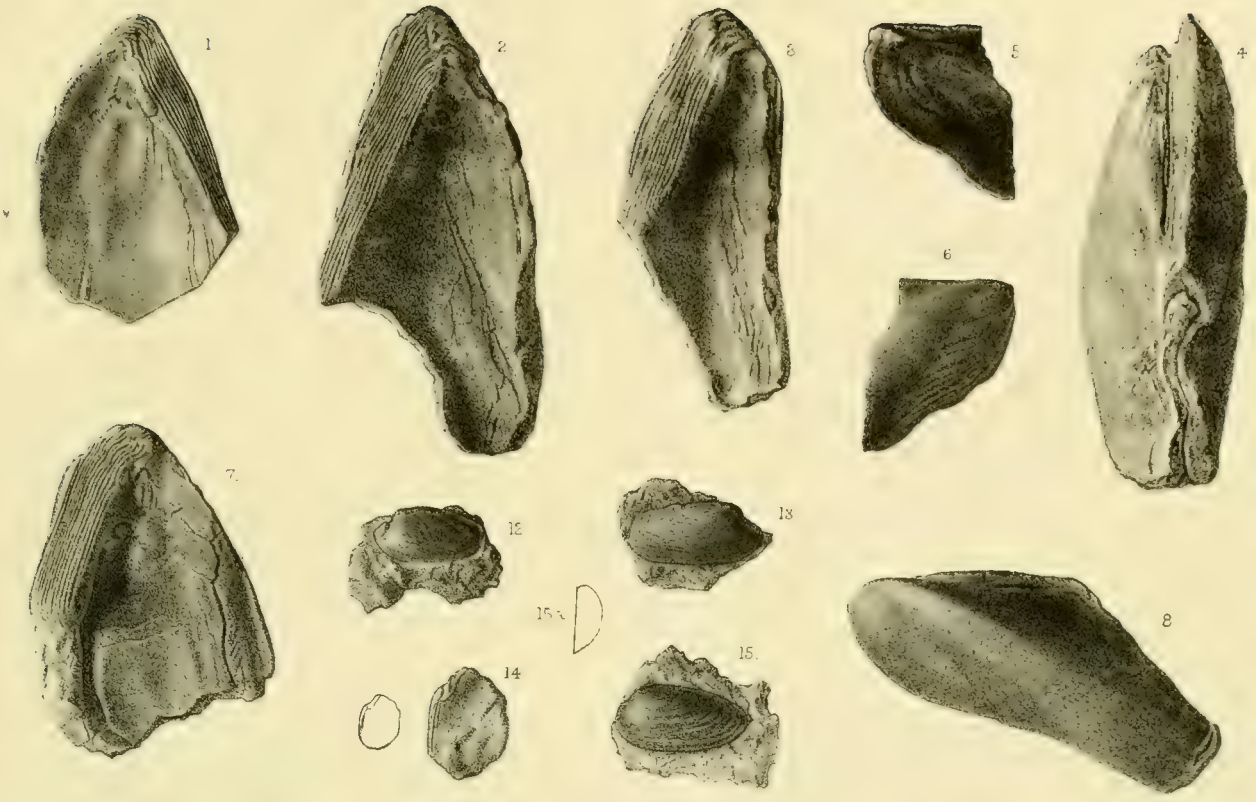
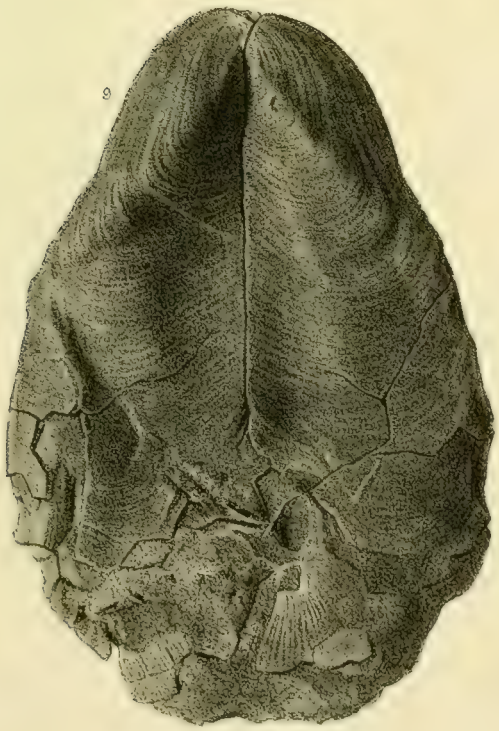
Fig. 14.—*Carbonicola elegans.* The hinge enlarged to twice its size. From the same locality. (Page 81.)





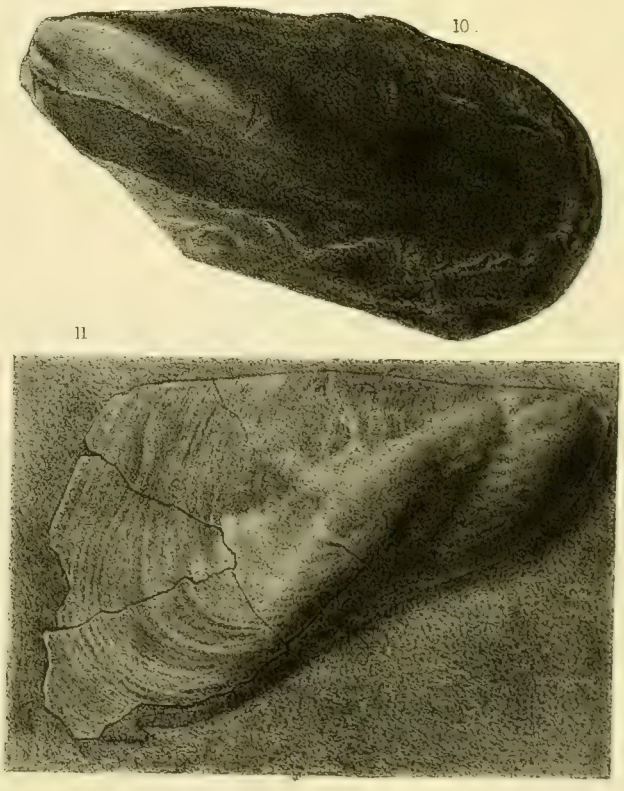


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PLATE XXI.

Fig. 1.—*Carbonicola acuta*. The original of Ure's "mussel" from East Kilbride. In the Collection of the Royal Society of Edinburgh. (Page 175.)

Fig. 2.—*Anthracomya subparellela*. The original of Portlock's *Modiola subparellela*. In the Collection of the Geological Survey, Jermyn Street. (Page 176.)

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Fig. 14.—*Anthracomya senex*. Lancashire Coal-measures. My Collection. (Page 175.)

Fig. 15.—*Anthracomya dolobrata*. Medium-sized specimen, somewhat shortened by crushing, from the Coal-measures of Lancashire. My Collection. (Page 176.)

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